DOCUMENT RESUME

ED 467 514 CS 511 248

AUTHOR	Van Scoter, Judy; Boss, Suzie
TITLE	Learners, Language, and Technology: Making Connections That Support Literacy. Creating Communities of Learning & Excellence.
INSTITUTION	Northwest Regional Educational Lab., Portland, OR.
SPONS AGENCY	Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE	2002-03-00
NOTE	71p.; Pictures may not reproduce clearly.
CONTRACT	ED-01-CO-0013
AVAILABLE FROM	Northwest Regional Educational Lab., 101 SW Main, Ste. 500, Portland, OR 97204. Tel: 800-361-7890 (Toll Free); Web Site: http://www.nwrel.org; e-mail: info@nwrel.org.
PUB TYPE	Guides - Non-Classroom (055)
EDRS PRICE	EDRS Price MF01/PC03 Plus Postage.
DESCRIPTORS	Early Childhood Education; Educational Objectives; *Educational Technology; Instructional Effectiveness; *Literacy; Technology Integration; *Young Children
IDENTIFIERS	Technology Role

ABSTRACT

This guide focuses on children and learning, while offering a picture of how technology can help to further educational goals. It includes anecdotes from the real world of the classroom which show how teachers are using technology to support and enhance students' literacy skills, creating opportunities for positive learning experiences, and helping students acquire confidence to use new tools to advance their own learning. Although young children are surrounded by technology, many educators are not entirely comfortable with these new resources, or wonder how best to integrate the tools of the Information Age into classroom practice in developmentally appropriate ways to reach a range of learners. This guidebook draws on both research and classroom practice to steer educators toward effective uses of technology to advance literacy. It is organized into these sections: Understanding Early Literacy; Understanding Technology's Role in Literacy; Meeting the Needs of Diverse Learners; Considering Technology; Putting It All Together; and Conclusion. Appendixes contain a discussion of professional development teams and how they enhance learning and teaching; and a 28-item annotated bibliography of print and online resources. (Contains 68 references.) (NKA)

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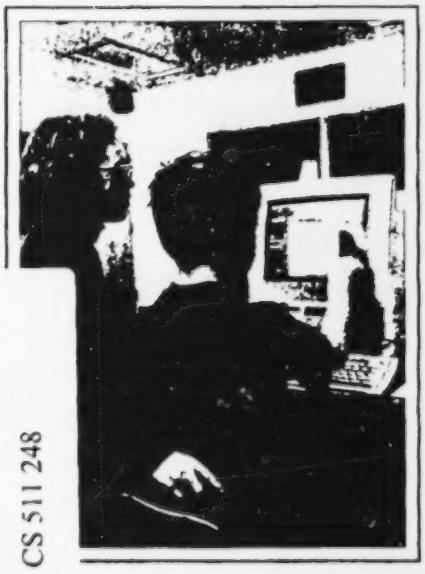

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This project has been funded at least in part with federal funds from the U.S. Department of Education under contract number ED-01-CO-0013. The content of this publication does not necessarily reflect the views or policies of the U.S. Department of Education nor does mention of trade names, commercial products, or organizations imply endorsement by the U.S. government.

Learners, Language, and Technology:

Making Connections That Support Literacy

by Judy Van Scoter and Suzie Boss

March 2002

Northwest Regional Educational Laboratory
Child & Family

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Acknowledgments

A number of educators provided valuable information and criticism during the development of this publication. Discussions and work during the past two years with colleagues in NWREL's Child and Family Program, in particular Debbie Ellis and Steffen Saifer, and in the Technology in Education Center influenced the ideas and direction of the work. The first draft greatly benefited from the comments of Kathy Fuller of the Office of Educational Research and Improvement; the guidance of Rebecca Novick, Seymour Hanfling, and Anne Batey; and the input of Maureen Carr, Kelly Kuntz, and Jana Potter. Appreciation is also extended to Linda Fitch for reference review, to Eugenia Cooper Potter for technical editing, and to Michael Heavener for design and production.

INTRODUCTION

Young children have always used a wide assortment of tools to explore the world and make sense of it. In the spirit of play they seize on whatever's handy, whether it's crayons for doodling, a trunk of old clothes for games of make-believe, or pots and pans for pounding out rhythms. Because educators understand that these early experiences help to shape children's language and literacy development, they create classroom environments filled with the tools appropriate for young children.

Technology offers new tools—including digital cameras, tape recorders, portable keyboards, computers, and software that allow for exploration and creation—with the potential to shape children's early learning experiences. These tools offer new experiences and additional ways of learning and understanding as they are incorporated into children's work and play.

Young children are surrounded by technology, both at home and at school. Yet, many educators are not entirely comfortable with these new resources, or wonder how best to integrate the tools of the Information Age into classroom practice in developmentally appropriate ways to reach a range of learners.

PHOTO BY MOUNT BURNS

To help children make wise use of these tools in the classroom, teachers need to understand the potential benefits and limitations of technology. This does not mean they must become technology experts. Many of the best examples of integrating these new tools into learning projects come from creative teachers who understand children, not from "computer teachers." Knowledgeable teachers need only recognize the power of technology to enhance learning, and take advantage of it in ways that support children.

In an active primary classroom, the teacher and children use a mix of traditional materials and new technology tools. The children in this class are at work in groups scattered throughout the room:

Some students draw crayon pictures that are then scanned into a word processor or authoring program such as KidPix, while others create pictures directly on the computer. Later, they will dictate stories to accompany their pictures. Across the room, another group uses a digital camera to take pictures of each other. The pictures will illustrate their biographies. Other children build designs with pattern blocks. Using yarn, they mark lines of symmetry, and take photos of the completed designs. Meanwhile, in a quiet corner, a parent volunteer tape records a student reading aloud a story. This activity will happen several times during the year with each child, so that students can hear their own progress as they listen to the recordings. Yet another group is "reading" a talking book on the computer, listening to the spoken words as the speech synthesizer turns letters into sounds.

Education has changed greatly from the early part of the 20th century, when the focus was on acquiring simple literacy skills, to education at the beginning of the 21st century. Today's students are expected to go beyond rudimentary skills and learn to think and read critically, to express themselves clearly and persuasively. Educators are asked to reach an increasingly diverse population of students and help them master complex skills at a high level (Bransford, Brown, Cocking, Donovan, & Pellegrino, 2000; Roschelle, Pea, Hoadley, Gordin, & Means, 2000).

A National Research Study suggests that "different kinds of learning goals require different approaches to instruction; new goals for education require changes in opportunities to learn" (Bransford et al., 2000, p. xvi). The same study then links the design of learning environments to the process of learning, and offers four important aspects to consider:

- **Learner-centered.** Learners use their current knowledge to construct new knowledge. Learner-centered environments help students make connections between their current knowledge and the new tasks.
- **Knowledge-centered.** Young children can understand more complex concepts than previously believed, but concepts must be presented in developmentally appropriate ways, linking learning to their current understanding. A knowledge-centered perspective highlights learning with understanding, rather than the acquisition of disconnected facts and skills.
- **Assessment to support learning.** Feedback is fundamental to learning. Assessments need to reflect the learning goals. If understanding is valued, then formative assessments—which give feedback during the learning process—provide opportunities for students to revise and improve the quality of their thinking.
- **Community-centered.** Learning environments that promote a sense of connectedness among students, teachers, homes, and the larger community increase opportunities and motivation to interact, receive feedback, and learn.

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Thus far we have changed the expectations for student achievement, but have not always taken full advantage of new knowledge about how learning takes place, and of new tools available to meet the challenge. Technology can be a useful and productive part of an environment focused on learners and their understanding. Examples in this guide will also show how technology can be used for assessment that supports increased learning and can contribute to building community within and beyond the school walls.

This guidebook draws on both research and classroom practice to steer educators toward effective uses of technology to advance literacy. It explores some of the many possibilities these new resources offer for education, and describes how this broad assortment of tools can be used in meaningful ways with students through the early elementary years. Those who work with older students and students with special learning needs will also find much of the information relevant and applicable.

In an effort to make this a practical resource that will assist teachers and others in the education field, the material is organized into these sections:

- **Understanding Early Literacy**: How children develop literacy skills through social learning, play, exposure to print-rich environments, and other contexts for making meaning
- **Understanding Technology's Role in Literacy**: The role technology can play in the development of language and literacy skills
- **Meeting the Needs of Diverse Learners:** Using technology to support the needs of English language learners, struggling readers, and students who would benefit from alternative assessments
- **Considering Technology**: Guidelines for effective use of technology and the selection of software and other tools for young learners
- **Putting It All Together:** Stories from real classrooms that beautifully tie together the tools of technology with the larger learning community of the young child
- **Conclusion**
- **Appendices:** Sections on professional development teams, and annotated bibliographies of print and online resources for further information on technology and literacy

This guide focuses on children and learning, while offering a picture of how technology can help to further educational goals. It provides practical information on using the many tools of technology to support literacy and language development. Throughout the guide, readers will find anecdotes from the real world of the classroom. These examples show how teachers are using technology to support and enhance students' literacy skills, creating opportunities for positive learning experiences, and helping students acquire confidence to use new tools to advance their own learning.

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UNDERSTANDING EARLY LITERACY

Literacy has its beginnings when a child is born and develops through the uncounted experiences of everyday life. From the earliest interactions with others, a child hears and absorbs language. Babies respond to the tone of words spoken by their parents and others who cuddle and care for them. Language development is closely tied to the individual relationships and early experiences of the child and the emotional quality these experiences carry. Oral language is the foundation for all literacy.

While we know from observation and research that young children are active users of language, we also know that early literacy development does not simply happen. Positive expectations about and experiences with literacy from an early age provide a base for successful literacy development (Snow, Burns, & Griffin, 1998).

Children's learning is prompted by personal involvement as they communicate for a purpose. What's more, all learning takes place in settings that have particular sets of cultural and social norms and expectations. Through social interactions, informal learning experiences, and more formal instruction, a child acquires the complex array of skills associated with the activities of making, interpreting, and communicating meaning. (Bransford et al., 2000; Padak & Rasinski, 1999).

Literacy involves learning to integrate the four interrelated activities of speaking, listening, reading, and writing. During the past 20 years, we have learned a great deal about how children learn to read and write by studying the literacy development of children who come from homes with rich oral and written language environments. In such homes, children's efforts at storytelling, reading, and writing are accepted with interest and enthusiasm and enhanced by adult questions and encouragement. Songs, nursery rhymes, and other forms of wordplay build phonemic awareness (the ability to hear the separate sounds in words), while encouraging the creative use of language. When adults and older siblings read to themselves and out loud to infants and children, they demonstrate the importance, and enjoyment of, literacy (Kontos, 1986; Snow, Burns, & Griffin, 1998).

Guided by an understanding of how learning takes place, educators can use this information as they design classroom procedures and make instructional decisions about how to accomplish particular goals. Before we explore specific ways that technology can be used in the well-designed primary classroom to promote literacy, let's take a look at how and in what contexts children develop language skills.

Social Learning

Children have a natural tendency to explain their world, explore with language, and challenge each others' thinking. The brain is social and is shaped through interactions with early environment and interpersonal relationships. Research on brain development has provided physiological evidence that early experiences and interactions do not just create a context for early development and learn-

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ing, but directly affect the way the brain is wired. In turn, this wiring profoundly affects emotional, language, and cognitive development.

While the brain continues to form new connections throughout the life cycle, there are periods during which the brain is particularly efficient at specific types of learning. Human interaction is crucial for normal development, and humans have a natural desire to learn (D'Arcangelo, 2000). Early experiences with literacy are closely tied to a child's emotional and social development.

As innately social beings, children learn language as a natural part of development through their everyday conversations with siblings, parents, grandparents, and caregivers. In fact, these are rich opportunities for learning because the child can use the context to help figure out the meaning of words and the sentence structure.

The Home-School Study of Language and Literacy Development conducted by researchers Dickinson and Tabors (2001) found strong evidence that teacher-child conversations, in which children play an active part, have an important role in shaping children's language and early literacy development. In particular, they concluded that the quality of teacher-child extended conversations throughout the day has a significant bearing on the child's long-term language and literacy development. Extended conversations that included personal narratives, explanations, pretend play, talk about past and present events, and discussions of ideas were particularly helpful for language development.

Because language learning occurs in a social context, people make activities such as writing and reading interesting and meaningful to young children. Parents, caregivers, teachers, and others play critical roles by modeling the use of literacy skills in their daily lives. Teachers work collaboratively to provide a socially supportive atmosphere that encourages children to share ideas and strategies, exchange writings, and challenge each others' thinking.

Activities such as reading recipes, looking in the newspaper for movie listings or sports scores, or reading e-mail messages show children the usefulness of literacy. Adults also provide children with the materials for drawing (the forerunner of writing) and reading, demonstrate their use, encourage and offer help, and communicate expectations.

Learning Through Play

You do not have to be a researcher to know that infants and young children love to learn through play and exploration. Indeed, exploration and discovery are their primary teachers. Mental and physical actions support each other in early childhood, and learning engages both the mind and the body. Recent brain research demonstrates the need of young learners to experience life kinesthetically and to learn through experiences that engage all the senses.

Pretend play is a valuable part of early literacy development, providing important opportunities to develop language skills. In fact, the amount of time that children engage in pretend play is correlated to their performance on language and literacy assessments. Their conversations in the preschool classroom are related to a broad range of skills using oral language and print that are evident by the end of kindergarten (Dickinson & Tabors, 2001). A broad range of skills using oral language and print that are evident by the end of kindergarten have their roots in conversation in the preschool classroom.

Play offers rich potential for practicing and experimenting with literacy. In the primary and early childhood classroom, center areas can provide children with literacy props for dramatic play, such as house play, or restaurant, transportation,

post office, or office play. Teachers have found that nonworking machines, such as typewriters, telephones, computers, and keyboards, facilitate role-playing and give children opportunities to use language in their play. Providing students with math manipulatives and materials for hands-on science activities allows them to use both their bodies and minds for learning, and creates opportunities for spontaneous conversations that promote the development of language skills.

Children's ability to draw and to represent actions symbolically in dramatic play are important steps in early literacy development, and precursors of successful reading and writing. Research suggests that story reading, providing materials for scribbling and "writing" in pretend play, and participating in extended conversations are among the activities that promote emergent literacy skills (Bowman, Donovan, & Burns, 2000).

Print-Rich Environments

Spoken language and reading have much in common. A child develops language skills long before being able to speak and develops literacy skills long before being able to read. Making sense of written text depends on oral-language abilities, and requires an understanding of the meanings of words. There is "a consensus that the environments of young children should be language-rich, with lots of words used during interesting conversations, and should be enriched by stories and explanations" (Snow et al., 1998, p. 5).

Just as children learn to talk by using language in a purposeful manner, they can learn about written language in an environment enriched with meaningful messages and functional print (Warash, Strong, & Donoho, 1999). Print-rich environments surround children with words—signs, labels on objects, sign-in sheets, and charts. Teachers show that print is functional by building on opportunities that occur as part of the daily routine. Charts and lists posted around the classroom might record helpers, children's names, lunch count, or children's favorites. Any way that print can be integrated into the surroundings is helpful for,creating an environment conducive to early literacy development.

Charts can be as simple as printing a name on a large sheet of paper in a column under a favorite food or favorite activity, or adding a name to a column in a database or spreadsheet. They provide another way to communicate ideas and observations, and are best used for information that has value or meaning to students. Teachers frequently use charts to help young children see relationships and make comparisons (Warash et al., 1999). Charting experiences in preschool and kindergarten lead into understanding of graphing

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and mathematical comparisons as children grow into more complex work with data and information.

Schickedanz (1999) describes a classroom environment where children experiment and play with all kinds of different papers and a variety of writing tools—a writing center much like a block area or water table. She has found that children take advantage of the "props" and often scribble messages to parents, grandparents, siblings, and teachers, imitating the writing they have seen. Children playing at this center might also ask an adult to write down the words they dictate. Dictating provides valuable literacy practice for children, as they choose what they consider important to record from all that might be said (Padak & Rasinski, 1999).

Early childhood classrooms cultivate written literacy by providing materials to use in pretend play and by encouraging children to express themselves in writing (IRA & NAEYC, 1998). Having a wide range of materials always available for children to use—crayons and pencils of all kinds and sizes, stamps and stamp pads, papers and scissors, glue, typewriters, and computers—creates a high level of interest and gives children many ways to explore print and express themselves (Warash et al., 1999).

Language and Literacy Development

Early experiences with language help prepare children for reading and writing. The well-designed primary classroom offers children opportunities to express their own creativity, hear books and poetry read aloud, read aloud to others, dictate or write stories, and engage in dramatic play and in myriad other activities that involve language.

Researchers agree that reading is the process of constructing meaning from written texts (Anderson, Hiebert, Scott, & Wilkinson, 1984). During this process readers join together information from the written text with their own knowledge and experiences to "make sense" of the text. "Thus, readers derive meaning from text when they engage in intentional, problem-solving thinking processes" (National Reading Panel, 2000a, p. 14).

Teachers are familiar with this interaction between students' personal knowledge and their comprehension of text. When a group of children reads the same poem or story, each one derives a slightly different message from the words, reacting to them based on what he or she brings to the text.

As we have seen, meaningful experiences form the foundation for students' learning. Prior to reading and writing, children need experiences in which they are surrounded by rich oral language. Such opportunities are critical, and their value should not be underestimated.

UNDERSTANDING TECHNOLOGY'S ROLE IN LITERACY

When we speak of technology, many people automatically think of computers. While there is no question that computers offer great educational opportunities and benefits, technology can be much more broadly defined as "any tool or medium that helps people accomplish tasks or produce products more efficiently" (Healy, 1998, p. 30). Educators can also take advantage of the many other tools of technology that are widely available and useful in the classroom. These tools include digital cameras, tape recorders, portable keyboards, a wide range of graphics and multimedia programs, and more.

The National Research Council has explored ways that new technologies can be used in the classroom. Among the council's findings are several specific ways technologies can be used to support learning. These include:

- **Providing scaffolding and tools to enhance learning and help children solve problems.** For example, "talking" word processors support young children's experimentation as they play with language. Using word processors, children can compose and write more easily than with pencil and paper. Technology provides children with the additional support they need to be successful as they increase their skills.

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- **Providing more opportunities for feedback, reflection, and revision.** Through the ability to go back and revise earlier efforts, technology encourages reflection and improvement of work. Opportunities for feedback increase when work is made available through printed copies, electronic copies via e-mail or the Internet, or made into audio or video recordings. With access to printing in the classroom, or publishing to the Internet, children can reach a larger audience who provide motivation for writing, thus encouraging a more polished final work.
- **Building global and local communities.** Technology can promote understanding and help to build communities by linking students from across the country and around the world. Through e-mail exchanges and projects that depend on distant collaborators, children can come to see and understand the similarities among different groups and different cultures, and the relatedness of communities.

(Bulleted items paraphrased from Bransford et al., 2000)

Young children and their teachers are blending new tools with the traditional, showing how both can be part of a rich array of literacy experiences.

Technology adds to the set of tools available for children to use and adapt, to feel at home with, to make part of their repertoire, and to help express themselves, verbally, visually, and emotionally. New technologies offer teachers additional resources to use as they plan to meet a range of levels, learning styles, and the individual needs of students.

Computers and other technologies do not replace other tools or activities, but add to the teacher's complement of tools. "In teaching as in carpentry, the selection of tools depends on the task at hand and the materials one is working with" (Bransford et al., 2000, p. 22). With experience and guidance children will develop the skills needed to choose the appropriate tools to express themselves. Consider, for example, this description of a classroom where children use a variety of tools in literacy-related learning experiences:

"In a second-grade classroom near Boston, I watched two eight-year-olds create their own classroom newspaper. They used a template from a publishing software product to create the banner, and selected the two-column format. Then they imported digital photographs of teachers and children in their school and added captions below each image. Earlier that day these same children had listened to their teacher read a (printed) Russian folk tale aloud to the class, exchanged handwritten messages on scraps of paper, and checked their e-mail messages. They navigated seamlessly from one medium to the next without hesitation, understanding literacy in ways that were difficult to imagine 20 years ago."

(Wood, 2000, p.117)

In this classroom and others like it, young children and their teachers are blending new tools with the traditional, showing how both can be part of a rich array of literacy experiences. As we consider the role that technology can play in literacy, it is helpful to keep in mind the four interrelated areas of speaking, listening, reading, and writing, as well as the contexts for learning discussed in the previous section on early literacy. To make appropriate use of technology in the early elementary classroom, it's important to find opportunities that assist or engage children in pursuing these fundamental activities.

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Social Learning and Technology

A kindergartner enters her name on a computer keyboard and then has the software program "read" it aloud. It's so much fun to hear the machine say her name that she then types in the name of a friend who is watching her. The process continues as more children come over to participate. When a name is accidentally spelled wrong, the children hear the error and quickly correct it. Then they begin to play with the language deliberately, changing the first letter of a name to hear how it sounds. They are rewarded with a rhyming word, which inspires more experimenting with names and sounds.

Technology is sometimes perceived as being at the opposite end of the spectrum from social interaction and personal engagement. Yet, we know that social interaction early in life is critically important for language development. No wonder, then, that researchers have paid particular attention to technology's effect on the social interaction of children.

Researchers consistently report high levels of spoken communication and cooperation as children interact at computers (Clements, Nastasi, & Swaminathan, 1993). Young children are able to and even prefer working with one or two partners at the computer. Young children initiate interactions more frequently and in different ways at computers, and primary students collaborate more while working on the computer than they do when using pencil and paper. Computers can also contribute to the social interaction of young children with disabilities; involving, interactive software programs become a topic for conversations and communication, even for children who tend not to communicate (Hutinger, 1996).

> "Computers, like crayons or blocks, are tools for learning and problem solving."

Both research and teacher anecdotes point to the positive effects of computers and other forms of technology on social interaction, when the environment and activities are designed to encourage communication. In a busy classroom, conversations about activities lead to improvement in language skills and development of vocabulary.

PHOTO BY DENISE JARRETT-WEEKS

The teacher plays a central role in the process of using technology, encouraging collaboration among students and independence in activities. "Computers, like

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crayons or blocks, are tools for learning and problem solving. Teachers play a critical role in determining the manner in which these are used" (Clements & Nastasi, 1993, p. 254). Just like books or any other resources, technology is used within a social environment, and mediated by interaction with peers and teachers (Bransford et al., 2000). Learning is never solely a matter of hardware and software.

➤ CLASSROOM STRATEGIES:

- As children learn how to use a digital camera or scanner, have them teach others how to do it. When they explain the process to someone else, it reinforces the task for them, and strengthens verbal communication skills.
- To create opportunities for language and collaboration, plan tasks that require peer interaction and arrange the space so that two or more children can sit and work together at a computer.
- Coach adults to talk with the children about what they are doing, and to ask open-ended questions to build language and social skills.

Play, Technology, and Literacy

Children gather around a portable, handheld microscope. They use it to explore their skin, strands of hair, and their clothing. When the magnified images appear on a computer screen, students reveal their fascination with the way everyday objects appear under 50-power magnification. Conversation flows. The teacher guides them to examine a leaf and offers the proper terms when the children attempt to describe what they see. In the context of shared exploration, children are introduced to scientific vocabulary. This is particularly beneficial for students who learn best from experiential learning, including many English language learners.

Play and literacy activities using technology serve educational objectives within the broader curricular and program goals. Children have traditionally made meaning using blocks, crayons, pencils, and art materials, as well as through pretend play and oral storytelling. Now, the tools of technology—including computers, software, and items such as the handheld microscope in the example above—can become sophisticated tools of play and learning in early childhood education settings. Young children are increasingly using authoring programs, such as KidPix or HyperStudio, to tell stories in pictures and words. Such programs allow children to enhance their projects and

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writing with graphic images, sound, speech, motion, color, and scanned images that engage the senses and enhance the learning experience (Liang & Johnson, 1999).

As discussed earlier, children learn through multisensory experiences, using their bodies and their minds in tandem to learn through play. The playful exploration of early years is the original version of the experiential learning that is so effective in engaging students. Children's play is open-ended. There is no fixed sequence or final destination in the play as children use their imaginations and try out new roles and ideas. Both play and experiential learning lead to deeper understanding for the same reasons—children have experienced the learning with their senses as well as with their minds.

Play does not cease to be a useful activity; as children grow older it continues to be an important part of literacy development and experiential learning. The rich environments of preschools and kindergartens that allow for student exploration and experimentation can be models to also include in higher grades, as we take responsibility for reaching diverse learners. There is much evidence that students learn in a variety of ways, and that traditional, uniform teaching practices cannot reach all students. Expanded avenues for learning—through interactions, simulations, student choice, arts, and much more—can address different learning styles, provide meaningful, engaging experiences, and allow students to use and build on their strengths, and so to perform well (Green, 1999; Sprague & Dede, 1999).

➢ CLASSROOM STRATEGIES

- Make available opportunities for children to role-play what they know from their own environment and experiences: "writing" a note or list on paper, typing on the computer in imitation of a parent at work, using an adding machine to total purchases at the post office. These types of play provide experiences with the materials of writing and literacy.
- Include technology, such as a computer and printer, within centers rather than placing it in a separate area away from art, drama, or other play centers. This conveys to children that the technology is integrated into activities throughout the classroom. Centers can be rearranged from time to time, or carts can move the technology to different centers to encourage other uses.

Print-Rich Environments and Technology

Brightly colored banners hang in the grocery store corner of the classroom. Children "write" shopping lists on pads of paper available in the shopping area. Signs hang from shelves and mark areas of the store, and an adding machine sits on a table to total purchases. A computer and printer are nearby, along with crayons and paper, so children can make new signs when they want. As they play, children pick up boxes to look at the words on the labels and engage in conversations about their choices.

Children in this example are playing at shopping, and playing with language. Just as classroom signs, charts, and labels immerse children in a

PHOTO BY DENISE JARRETT WEEKS

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print-rich environment, technology can also serve as an excellent exposure to print. When children have access to resources including computers and other technology during the day, they can choose to draw and write with paper and crayons, or use software programs that let them experiment with language, create stories, or type words to accompany photos or pictures.

As children share their connections to the text when they listen to a story or read to themselves, teachers can list the ideas on a large sheet of paper, or enter children's comments into a computer and display the text on a large monitor to the whole class. The chart can then be printed and a copy given to each child with a record of the vocabulary and ideas generated by the entire class. The benefit is the same regardless of the technology used: Seeing their spoken words turn into words on a page helps children make the connection between sound and print.

➤ CLASSROOM STRATEGIES:

- Word walls or word banks surround learners with words that can be incorporated into a variety of activities to support literacy development. Use technology as one of the ways to build the bank—type and print words from the computer, or make prints of digital photos that include new vocabulary, or words important to the children.
- Use a computer and printer in the classroom to help children make signs, banners, and other props for pretend play. The props add interest and basic literacy skills to children's play, and decisions involved in making them—what size, what color, what words—give children more opportunities to use language. Making and displaying signs helps create an atmosphere that surrounds children with print that has meaning to them.

Literacy Development and Technology

The Head Start program in Portland Public Schools serves students of diverse cultures and languages. Teachers often send home digital photos of activities such as zoo visits and open houses. Captions are deliberately omitted, so that when the children share the pictures with their families they use their home language. When children share their activities and excitement at home, it reinforces both the learning from the activity and their native language, an important background for literacy development for those whose second language is English. The program also uses the digital cameras to document experiences with the community, such as field trips and guest artists, further enriching children's connection to the world outside school.

Technology offers a variety of ways for children to weave together words and pictures.

Educators use many tools and activities as stimulants for language, to provide opportunities for discussions and allow introduction of academic and content area vocabulary. When technology encourages conversations, as in the Head Start example above, children learn that they can use language to ask questions, make comparisons, and tell stories about their own experiences.

Children learn a language best, whether a first or a second language, by using it to communicate rather than studying it in isolation (Garcia, 2000). To encourage children to use their emerging language skills, teachers frequently send home photographs of children and their school activities. With digital cameras and printers commonly available, it is even easier for teachers to print

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and send home photos or newsletters with pictures from a field trip. The photos provide opportunities and great motivation for young students to discuss school activities with their families, and so expand their oral communication skills and build vocabulary.

Young children make up stories as they play, and frequently tell stories that go along with pictures they create. Technology offers a variety of ways for children to weave together words and pictures. Children who are not yet writing may dictate words that others type for them or, using a child-friendly authoring tool, they may record their voices telling the story. Either of these records can be printed out, or saved electronically as a part of their portfolio, as a record of achievement. Children may also be videotaped as they tell the story and show the picture.

For children writing their own stories, word processors help them to get their words onto paper and to match them with pictures. Using existing technology, pictures can include photographs, digital images, videos, or drawings that are scanned into the computer, and can even be animated. With computer graphics children often write and tell more detailed, elaborate stories than they do about static pictures (Clements & Nastasi, 1993). Young students can present or represent various aspects of their learning using computers and software to generate stories, pictures, graphs, and other materials (Murphy & Thuente, 1995). Technology makes it easy for children to "tell" their stories in ways that make sense to them, and then display them on the screen and print them.

Research points to several areas where technology helps to develop literacy skills in early childhood by promoting the activities of speaking, listening, reading, and writing. These interconnected activities are illustrated by the following classroom description:

Mrs. T introduced her first-graders to the "talking" word processor by showing them a few commands on the keyboard. The technology permits playful exploration with writing and spoken words, which is especially helpful for students who have special learning needs. She prompted children to help one another rather than the teacher being the expert at all times. As she encouraged children to use the computer for editing, they began to think of the text as flexible and something they could alter. The screen made the writing seem more public, and sharing seemed natural. The children took increasing responsibility for problems and decisions and over time took on more complex tasks, such as publishing a class newspaper. Mrs. T considers the program a success and would not be without computers in her classroom today.

(paraphrased from Clements, 1994, pp. 44, 46)

➤ CLASSROOM STRATEGIES:

- Model the writing process using an overhead projector or a computer attached to a multimedia projector. First, write a rough draft on a transparency or the computer. Then, mark revisions as you think out loud what to write. This lets students hear you "think through" your writing. Students can refer back to the example on the screen as they do their own writing—using pencil and paper or word processors.
- Print out photos and send them home, with or without captions. Photos without captions encourage oral language; those with captions develop written language skills.
- Encourage children to write by including a real audience. Simple class newsletters, e-mail exchanges, and collaborative online projects provide motivation as they write for an audience they know and care about. (See "Working With Words," Page 34, for more information.)

* * *

As teachers grow more comfortable and competent with the use of technology in their classrooms, they are discovering a variety of ways to promote development of students' literacy skills. Technology offers different approaches and new opportunities for learners, giving them options and a voice in their learning and an expression of their learning styles. Educators comfortable with these new tools can link technology use to broader goals that foster development of language and literacy skills. Technology can enhance the development of literacy by:

- **Opening opportunities for students to read and write for real purposes.** This might involve connecting students with people outside the classroom, with students involved in collaborative projects with other children on the Internet. Classes may write and send e-mail correspondence as well as send letters through the postal service to pen pals across the city or across the world.
- **Building a learning community.** Bringing students and teachers into contact with the broader community can raise cultural awareness, provide opportunities for families and community members to share their stories, promote intergenerational exchanges, and enhance self-esteem for children who are culturally and linguistically diverse. Modern technologies can help make connections between in-school and out-of-school activities. E-mail, for example, can make it easier for adults to share family stories (see the final section, Page 45, for examples of such sharing).
- **Giving students opportunities to tell their own stories.** Technology makes it easier to record these stories in a variety of formats. Children can dictate their stories to adults

PHOTO BY DENISE JARRETT-WEEKS

or older students, who transcribe them on the spot at a computer, a portable keyboard, or typewriter. Similarly, they can tell their stories into a tape recorder or on videotape for later transcription. (See Page 42 for further discussion of audio and video recordings.)

- **Demonstrating the value of lifelong learning.** When teachers are willing to take risks and venture into new areas, they create opportunities to demonstrate as well as talk about lifelong learning. They also allow children opportunities to provide real expertise as they teach new skills to peers. As teachers learn to use new technologies they often learn alongside their students. By showing their own skill development they model the learning process and can discuss it with their students, blurring the distinction between teachers and learners. Being the learner gives teachers permission to experiment and tinker, and stimulates their own thinking about the processes of learning. They gain new insights into teaching by watching their students learn (Bransford et al., 2000).

These benefits extend to all students. Next, we'll examine some of the ways technology can help to reach diverse learners.

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MEETING THE NEEDS OF DIVERSE LEARNERS

Most of the students were recent immigrants, but their experiences were diverse. Building on the important personal stories of the students, each wrote of his or her arrival in the United States. The class created a slide show using KidPix, a program that allows users to create original artwork or use stamps included in the program. Students designed their slides to include information about their home countries and about themselves. They used writing skills to plan oral presentations to record onto their slides; some made notes, some a list, and still others wrote paragraphs introducing themselves. This was a learning experience for several students, as they found that they needed more planning and practice to feel confident when they spoke. The technology permitted students to revise the artwork and the recordings at any time, and many students returned to revise pictures and rerecord the audio portion. Students often listened while other students were editing the audio; within a short time students' spoken English fluency improved noticeably. The focus was on the writing process and the success of each student. It is a sign of motivation that children had to find time between other activities to work on this project with the one computer in the classroom.

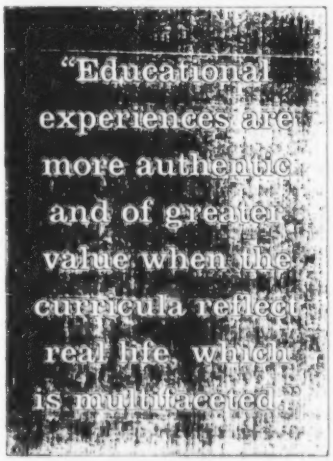
(Summarized from Duling, 1999, pp. 251-252)

PHOTO BY DENISE JARRETT-WEEKS

With increasing diversity in classrooms, educators are striving to meet the learning needs of students from widely varied cultural and linguistic backgrounds. As the above example illustrates, technology can be a powerful tool to engage all learners.

Before exploring how technology can serve students with specific needs, let's review what we know about best practices for serving diverse learners. The research literature strongly makes the case that all learners are diverse in many respects (Garcia, 2000).

To meet the challenges of educational reform, the major national subject-matter organizations have developed guiding principles based on the belief that "educational experiences are more authentic and of greater value when the curricula reflect real life, which is multifaceted" (National Council of Teachers of English, 1995). They recommend that interdisciplinary curricula for pre-kindergarten through fourth grade should:


"Educational experiences are more authentic and of greater value when the curricula reflect real life, which is multifaceted."

- Foster a learning community, and respect a diversity of thought and culture; students should learn through a variety of learning strategies, learning experiences, and perspectives
- Provide a variety of opportunities for interaction and collaboration among diverse learners—for example, discussion, investigation, drama, and telecommunications
- Teach students to use a wide variety of sources, including primary sources, oral communication, direct observation, and experimentation; the use of multiple sources accommodates various learning styles, interests, and abilities
- Use multiple symbol systems—such as those used in language, mathematics, music, and art—as tools to learn and present knowledge
- Use wide-ranging assessments to evaluate both the processes and outcomes of student learning; formal and informal assessments can include observation, portfolios, and performance assessments

These approaches outline effective ways to engage young learners. They have the potential to reach all students in the classroom, including those who may not succeed in less inclusive or more traditional settings.

Technology can be a powerful tool to use along with these recommendations. Computers, software, tape recorders, and cameras can contribute to a variety of opportunities and collaboration among students, including those at a distance who may communicate through e-mail and Web pages. The Internet provides classroom access to primary source material and other resources previously unavailable to most researchers; tape recorders and video cameras enhance the possibilities of recording oral histories and oral source material. Computers and cameras offer additional ways to record and assess student achievement.

Indeed, teachers are finding that technology can support and enhance effective classroom strategies to build language and literacy skills for students with a variety of needs, including English language learners, struggling readers, and students who would benefit from more varied assessments of their learning.

English Language Learners

Hands-on, experiential learning is recognized as a strategy that enhances understanding for ELL students, and technology offers a wealth of experiences to engage these language learners. Immersing students in experiential activities encourages true learning, and is particularly effective with children learning English as a second language. Technology can be incorporated into hands-on activities (such as those involving math manipulatives, science experiments, or social studies skits) that allow students to use both their bodies and their minds for learning. Experiential learning also provides opportunities for students to work collaboratively and many opportunities to practice oral speaking, strategies

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that support the success of students who are learning English. (Costantino, St. Charles, Tepper, & Baird, 1999; Duling, 1999)

To participate in the classroom dialogue in a meaningful way, students need to share common experiences, such as being part of classroom activities that are used as the base for further learning. To support English language learners, classrooms and schools must provide many avenues for exploring, learning, and practicing reading, writing, speaking, and listening. Technology offers special promise for ELL students because it allows them to learn at their own pace in a nonthreatening environment, gives students flexibility and choice, and empowers them to make learning decisions and to be successful.

Duling (1999) describes an elementary teacher who uses cartoon strips to engage students who are beginning English language learners:

> [The teacher] selects wordless cartoon strips that students can easily understand by looking at the pictures. She first asks students to describe the picture or story orally. Telling the story becomes a rehearsal for writing as children then write their story or explanation. They can choose to either type their words on the computer or to dictate the story. Using the computer removes difficulties or discomfort with forming the letters and allows them to focus on the meaning of the text. As the students become more skilled at describing the cartoons they are offered more complex cartoon strips (paraphrased from Duling, 1999, pp. 250–251).

The appeal of the wordless pictures, combined with technology to support the process of creating written language, motivates learners as they work with new language skills. The complexity of the pictures increases as students' language skills develop, encouraging further development. This

PHOTO BY DENISE JARRETT-WEEKS

same strategy can be used effectively with beginning or reluctant writers as well, and can be further personalized by having children draw pictures for others to use as the basis of the story.

Supporting literacy and language skills in the first language provides a base for successful literacy development in the second language (Snow, Burns, & Griffin, 1998). Many English language learners have experience with immigration, either personally or through hearing family stories. Interviewing parents or relatives about their immigration fits into the social studies curriculum and enhances literacy. Children frequently conduct the interviews in their first or native language, and later translate them into English. Because they understand and have a connection with the content there is a motivation and desire to make sense of the language. Technologies that support this activity include tape recorders or video cameras to record interviews, and word processors for students to use as they transcribe the interviews and translate them into English.

PHOTO BY DENISE JARRETT-WEEKS

A learning experience that engages students in the study of their own community or culture creates a bond between students and families, generating a wealth of known information for students to read and write about, and to use in other content areas. (See sidebar on Project FRESA, Page 23.) In valuing personal experiences and the community, such projects also affirm the students' sense of self and the value of their culture. The use of technology adds to the motivation and interest, as well as to the quality of the final product.

LEARNING THE VALUE OF PLACE

Two teachers from Mar Vista Elementary School in Oxnard, California, created a cross-curricular project to help students understand the relationship between their own lives and the strawberry crops that surround and sustain the local community. Project FRESA is the collaboration developed by fifth-grade teacher Michelle Singer and third-grade teacher Amada Irma H. Pérez. Most of their students are immigrants from Mexico who speak English and Spanish. Both teachers are also bilingual.

To understand the importance of strawberries to local farmworker families, the environment, and the economy, students conducted family interviews, did research via the Internet, collected historical and geographical information, and used technology to share their findings with their school, their homes, and the global community. The interdisciplinary nature of the project meant that lessons crossed boundaries of language arts, math, and geography, and technology was used in a variety of ways. Also central to the project was the teaching of critical thinking and education to combat racism. Giving students the opportunity and language skills to voice their daily reality was a goal throughout Project FRESA.

The project offered students many avenues to develop their language skills while investigating complex topics that affect their own lives. The project Web site highlights language arts activities that reach students of diverse backgrounds and learning styles, including:

- Accessing students' prior knowledge about strawberries through brainstorming and making charts to share "what we know, what we want to know, what we learned"
- Having students interview family and community members
- Making oral presentations of their findings
- Conducting research through encyclopedias, newspapers, and magazines
- Doing quick writes on experiences related to the farmworker occupation and to the geographical area
- Writing journals
- Creating art and poetry
- Engaging in ongoing dialogue
- Posing a problem, leading to action

Students used tape recorders for interviews; still cameras, digital cameras, and video recorders for documentation; the Internet for research; word processing software for writing; spreadsheets to create graphs of information; and scanners to convert artwork and photographs to digital images. The use of technology was a central part of Project FRESA, but not the focus of the project. Each classroom had only one computer. With creativity, vision, planning, and dedication to exploring new ways of looking at and using technology in the classroom, all students received equal access to the technology.

The project allowed students to use both their English and Spanish skills to read, write, speak, and listen. Teachers Singer and Pérez point out:

> Students can communicate in one language with their parents, analyze and present information gained in another. Language is used for a purpose while developing vocabulary, grammar, research, and technology skills. All students have equal access and opportunities to actively participate in the project no matter the language, ability, age, or fluency level.

To see the Project FRESA Web site, go to:
http://equity4.clmer.csulb.edu/netshare/cti/%20FOR%20PSRTEC%20WEBSITE/Amada%20and%20Michelle/

Struggling Readers

Students who struggle with reading dread being called on to read aloud. They often appear disengaged from the learning process and experience low self-esteem, poor attendance, and discipline problems (Hasselbring, Goin, Taylor, Bottge, & Daley, 1997; Pinkard, 1999). A common but misguided response to struggling students is to reteach the same low-level skills in the same manner, keeping the focus on basic level skills in the belief that a fixed set of sequential skills need to be mastered in order to read (Duling, 1999). A child thus gets more of the same, frequently at the expense of other activities that would lead to improvement, such as concept building, reading, writing, and doing.

> Technology supports the learning and the rich experiences by offering options for students—especially important for those who fear failure.

Lower-order skills are less likely to hold students' attention, motivate them to learn, or enable them to transfer lessons learned across subjects. As a result, lower-level remedial activities rarely result in improvement in overall performance (Anderson et al., 1984; Garcia, 2000).

The use of technology for drill-and-practice activities does not improve these poor results. As Clements points out: "The effectiveness of computer learning depends critically on the quality of the software, the amount of time children work with the software, and the way in which they use it" (1994, p. 33). The most promising uses of computers are not as "teaching machines" and have nothing to do with programmed learning or drill-and-practice programs (Clements et al., 1993). A better approach is to engage students in activities that capture their interest and use these experiences as the basis for speaking, writing, and reading activities. (For more information on the selection of software, see "Considering Technology," beginning on Page 29).

Because reading and writing are more effectively taught in combination, word processing applications may be useful for improving reading skills (National Reading Panel, 2000a). Research also consistently notes the motivational benefits of technology. Seeing text on the screen encourages students to read their own and others' writing as they work at the computer, and the amount of time children choose to read and have opportunities to read strongly correlates with reading proficiency.

Teachers can build on student interest awakened by engaging activities to offer high-interest reading materials at a variety of levels. Picture books are a good source of high-quality literature suitable for a range of reading abilities. (See Picture Books sidebar, Page 25.)

PICTURE BOOKS

Picture books are sometimes overlooked as a valuable resource for encouraging children to enjoy reading and writing. While children above the primary grades sometimes consider themselves "too old" for picture books, teachers will find it easy to convince them otherwise. Most children have favorite books from their earlier years; introduce them to a few beautifully illustrated books written for upper elementary—and older—students with broader interests and larger vocabularies, and most kids are hooked.

When picture books are integrated into a classroom library, struggling readers are not stigmatized by reading them. Everyone is encouraged to enjoy the illustrations and text that is often rich with metaphor and poetic language. In a world increasingly moving toward oral language, pictures, sounds, diagrams, and videos, high-quality picture books can be effectively used with older readers. As one teacher explained:

I fill the classrooms with children's literature and picture books, those that contain the richest language and the finest illustrations. I collect children's picture books. The students know I value them because the room is filled with them. If they are mixed with all the other genres, there is no mistaking children's books as baby books. Good children's literature is for everyone, not just for young children (Benedict & Carlisle, 1992).

In *Beyond Words: Picture Books for Older Readers and Writers* (Benedict & Carlisle, 1992), teachers of older elementary, middle school, and high school students offer a wide variety of uses for both fiction and nonfiction picture books to:

- Examine genres, including historical fiction, legends, folk tales, fantasy, and poetry
- Complement a unit on science or history
- Study a variety of writing styles
- Teach reference and research skills to intermediate students
- Use as models in writing class

As models for writing, picture books are approachable for young authors. For children who love to draw, making their own artwork—with paints or crayons or created on the computer—draws them into the project, and the words follow. For those students who are intimidated by the thought of writing a lengthy piece, picture books require only a small number of words per page, and yet the child can write an entire book. Technology supports the learning and the rich experiences by offering options for students—especially important for those who fear failure—and by adding the advantages and polish of word processing; (digital or digitized photos may also be added).

Writing a picture book is also a good project to consider in collaboration with older or younger students. Dictating stories to accompany pictures allows prewriters to practice the language of storytelling, while older students take pride and receive satisfaction from using their technical and word-processing skills to accomplish an important task. When completed, the stories can be printed individually, or collected and compiled into a book for use in the classroom or the library.

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Alternative Assessment

A fourth-grade teacher undertook the first multimedia project she had ever tackled with her class. Students researched an animal, and were to develop a report using software that allowed them to create links between different topics in addition to the linear flow of a written report. When students linked related topics in ways demonstrating their understanding, the teacher better understood what they had learned. As the fourth-graders showed their multimedia projects to small groups of first-graders in their "buddy" class, conversations with the younger children also revealed the depth of student knowledge. The project made the teacher a convert to looking at multiple ways to assess student learning.

The students researched the animal reports using a mix of print and software materials, a blend of research sources that is becoming common. Because students were able to construct, link, and demonstrate what they had learned in multiple ways, due to the nonlinear possibilities of multimedia technology, the teacher was able to observe the depth of their understanding.

The National Reading Panel writes that many children may benefit from the addition of multimedia instruction to a conventional curriculum (National Reading Panel, 2000b). Multimedia applications offer a wide variety of ways for students to demonstrate what they have learned, providing teachers with alternative means of assessment. Consider this description of a second-grade classroom:

PHOTO BY DENISE JARRETT-WEEKS

Second-graders at a rural school create electronic portfolios. The teacher created a template in HyperStudio, a multimedia program, then students linked several samples of their work through the year. Students created electronic slide shows of their study of the planets and of Mexico, and recorded their voices onto the slides. The electronic portfolios also include periodic audio recordings of reading samples. Children and parents can readily hear the growth in reading ability from month to month, and children love to listen to how they sounded when they were younger.

A portfolio reflects a child's individuality, encourages the child to evaluate his or her own work, and supports a child's chances for success. Technology provides wonderful tools for developing formative assessments, valuable feedback that provides opportunities for children to revise and improve the quality of their work.

PHOTO BY MOUNT BURNS

Many teachers use portfolios to collect children's artifacts, pictures, narratives, and taped reading and speaking samples to document development and growth over time (Hutinger, 1996; Liang & Johnson, 1999).

Because children are best able to show learning in ways that express their individuality, many students benefit from multiple ways of looking at and assessing learning. For some, it provides a way they can succeed when they otherwise may not. Children with special needs or who learn in nontraditional ways may not always clearly demonstrate their achievement using paper-and-pencil methods of assessment. Portfolios are practical, useful planning and reporting tools, and portfolio assessment offers many benefits. It increases the teacher's awareness of how children learn; links activities, learning, and assessment interactively; guides and supports curriculum planning; and assists in communication with parents (Hutinger, 1996).

Other uses of technology also provide alternative ways of looking at student learning. For example, there are many ways for students to demonstrate reading comprehension. One is to create a database of the books they have read. The database can serve as an assessment tool to document that a student has read the book, and can also help to generate interest in books (Kahn, 2000).

A teacher may choose to create a template for younger students, with the class helping to decide what information to include; older students appreciate the flexibility and room for individual variation of selecting which additional fields (sections of the database) they want to add.

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Through summaries and their comments on the book, students demonstrate comprehension, and show their understanding of different genres and purposes for writing. As the classroom described below demonstrates, creating and adding to the database is motivating for students:

A Northwest teacher uses an integrated program supported by the district (AppleWorks) to have students create their own databases. The class first discusses which fields (database sections) must be included. The list typically reflects those with authentic purpose, mirroring other reviews students may be familiar with—summary, ratings, author, title, and copyright information—and may also include other fields that individual students choose to add. The discussion of which fields the class agrees must be included is valuable, as students think through the purpose of the project and the information a reader would expect to find.

Students add books throughout the year, and printouts are sent home quarterly to parents. Book entries reflect their growth in reading skill, comprehension, number and variety of books read, and writing skills as the year progresses. Students are happy to talk about their favorite books and what makes them special. In addition, students are eager to show the database during student/parent/teacher conferences.

CONSIDERING TECHNOLOGY

"Research has also moved beyond the simple question of whether computers can help young children learn. They can. What we need to understand is how best to aid learning, what types of learning we should facilitate, and how to serve the needs of diverse populations" (Clements, 1999, p. 93).

Technology offers wonderful opportunities for children to play, to learn, to create. Researchers have concluded that technology has great potential to enhance student achievement, when used in ways appropriate to the developmental levels of the children. As with any materials, however, these tools also can be used in ways that will not benefit students.

The design of the curriculum and the social setting are critical to the educational value of technology use. It's up to each teacher to provide guidance and make sure that it is used to meet appropriate instructional goals. The National Association for the Education of Young Children (NAEYC) underscores the role of the teacher in this process in its position paper: "Educators must use professional judgment in evaluating and using this learning tool appropriately, applying the same criteria they would to any other learning tool or experience. They must also weigh the costs of technology with the costs of other learning materials and program resources to arrive at an appropriate balance for their classrooms" (NAEYC, 1996).

The National Reading Panel has concluded that many questions still need to be addressed regarding technology's use for reading instruction (2000b). While we wait for research to catch up with educational applications of technology, this may be an opportune time for teachers to evaluate whether the newest technologies are delivering any better education for children in the early elementary grades than more old-fashioned tools—art supplies, blocks, books, and props to encourage pretend play (Healy, 1998).

In light of these cautions, two important questions may be considered when introducing young children to any new tool, including technology.

- Is it developmentally appropriate—consistent with how a child develops and learns—and with the child's current developmental stage?
- Will the activity benefit the child or will it replace other, more meaningful learning activities?

Other factors that educators should consider when incorporating technology include:

- Time: Young children need time to develop their memory, visualization skills, and attention span. Young children's attention naturally jumps around, but distracting graphics on television and computer screens may increase distractibility and make it harder for them to pay attention for sustained periods. Teachers may want to limit total "screen time"—including television and video viewing, video games, and computer use—and provide a healthy balance between the "electronic world" and the "real world." For example, if a student creates a drawing on the computer, ask her to build a three-dimensional model of it using blocks or clay. Encourage a child to sort objects in the classroom according to shape, color, or other

characteristics if he enjoys using a computer program that involves sorting symbols on the screen.

- Motivation: Learning takes persistence. Children need practice sticking with a task to develop the habits of mind necessary for solving problems and learning from mistakes. Some worry about the effect of software programs that reward impulsive, trial-and-error guessing over thoughtful problem solving, or that condition children to expect a reward (such as sound effects or enticing graphics) for every task completed. Teachers need to provide the necessary guidance to help children develop confidence in their ability as problem solvers and to persist, even if a task appears difficult on first try.
- Presentation: Word processing programs, ready-made graphics, and other publishing tools make it relatively easy for students to "dress up" their work. Teachers need to teach students that writing and art projects may go through many drafts or revisions before they reach final form—content involves much more than packaging. Rather than using ready-made graphics to illustrate their stories, encourage students to make their own drawings, which they can then scan for use on the screen. If students are writing for an audience—for a class newspaper or Web site, for example—make sure they edit and revise their work before it is published.

When used wisely, computers and other technologies give children opportunities to collaborate and socialize, to use language in meaningful ways, to engage their senses in play and discovery, and to connect with the wider world beyond the classroom.

Guidelines for Success

Some general guidelines will help teachers use these tools to best advance student learning.

1. Integrate technology into classroom activities.

For technology to be a useful learning tool, it needs to be accessible, available, and a part of regular classroom activities. When technology is available within the classroom the message sent to children is that it's part of the set of tools to be used in daily activities. Computers can be used when needed, rather than according to the computer lab schedule. Clements writes of young students who naturally turn to a talking word processor to use in their learning.

For technology to be a useful learning tool, it needs to be accessible, available, and a part of regular classroom activities.

"Two young girls were examining a picture-word card with a colored triangle. They were unsure what the word 'triangle' was and, after a brief discussion, walked over to the word processor, typed it in, and satisfied their curiosity" (Clements, 1994, pp. 34-35).

2. Let students use technology regularly, for real tasks.

Technology is of value when it accomplishes a purpose. When it becomes part of the regular classroom program the attention shifts from the tools themselves to their function: the ability to help perform a task. In the following example the technology is invisible—the children use the portable keyboards as naturally as any other classroom materials.

A group of primary students clusters around a table, writing and solving story problems. One child hands an AlphaSmart, a portable keyboard,

to the teacher who reads the problem aloud to the group. The group discusses the problem, and after agreeing on the solution, the children return to writing problems. Most of their time is spent on thinking through the language and concepts to create and solve the problems, the important elements of the activity.

3. Encourage students to work together.
Students benefit from an atmosphere that encourages collaboration and problem solving (Murphy & Thuente, 1995). Research supports the use of cooperative group interactions to increase understanding and success, as well as positive social interactions. Technology provides many opportunities for students to collaborate, and a classroom arrangement that allows two or more children to sit and work together encourages interaction and language opportunities. The students work in pairs in the following example, and discussion is built into the project.

PHOTO BY DENISE JARRETT-WEEKS

Second-graders are guessing how many of each color of M & M's will be in their packets. After each pair makes a prediction, students open the packages and sort and count the candies by color. When they have their totals, they go to the computer and enter the numbers into a spreadsheet. The children easily convert the data to a bar graph and a pie chart, and print out both versions to post on the wall.

Technology allows students to easily create different "pictures" that help them to compare and understand the results. These visual displays lead into class discussions comparing results across groups, hypothesizing the reasons for different findings, and introducing important vocabulary in a meaningful context.

4. Make a variety of tools available for student use.
Many classroom uses of technology do not require the newest or most sophisticated equipment. For example, tape recorders and cameras are useful learning tools. When students are offered choices, they are involved in making decisions about their learning. Teachers can incorporate a variety of technologies, giving students choices to address their range of learning styles and needs.

Students working on "convincing" writing are invited to use any available classroom resources to present their finished work. Some students decide to make a persuasive speech and display graphics and photos to support their arguments visually. One child writes and records a song to tell her ideas. Others use a word processing program on the computer to write, edit, and print their writing. Other students write the script for a commercial, which they act out and videotape.

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5. Do not teach technology skills in isolation. Real learning is based on connecting new information with existing knowledge. Rather than teaching technology skills in isolation, introduce specific skills as they are needed as part of classroom learning activities. A topic of study can be used as a way to introduce and practice certain skills while students accomplish real work, as the following example illustrates.

Students chronicle the growth of trees through the seasons with drawings, photos, and written descriptions. Children learn to use a camera when they take pictures of the trees. They practice keyboarding while they type their observations, and learn how to indent a paragraph when that skill is needed to organize their writing. By the end of the project, students have documented the growth of their writing and word-processing skills as well as the growth of the trees.

> The focus is on the learning, not on the technology being used.

6. Use technology to support active learning. Children learn by doing. Whether using a microscope to explore or paints and brushes to create, they need to interact with tools and with others. Experiential learning activities enhance understanding in a diverse classroom; such activities provide all students with common experiences. In a classroom in Concord, New Hampshire, a diverse group of children with a variety of needs combines technology with other learning experiences.

In a combination first- and second-grade classroom, students are preparing to share their reports on animals that hatch from eggs. These written reports are one piece of a project that required them to work in different modalities using art, construction, and writing. The classroom is filled with dioramas depicting environmental scenes, complete with clay chickens and snakes. For their reports, each student had to produce a draft that was handwritten and use the word processor for the final version (Ethier, 1999).

* * *

While not all six of these suggestions may be applicable at all times, keeping them in mind will encourage students to use technology appropriately and effectively to enhance learning.

Research also makes clear that very young children, and probably all of us, learn better in a stress-free environment. For learners of all ages, stress and threat negatively affect the brain—learning is enhanced by challenge but inhibited by threat. In the classroom this translates to a nonthreatening environment that fosters exploration and discovery so that children can test both their cognitive and emotional limits (Caine & Caine, 1997; D'Arcangelo, 2000).

So, too, must technology used by young children allow for exploration and discovery to align with their developmental and learning needs. Thoughtful planning by the teacher is essential so that the focus is on the learning, not on the technology being used to support the learning. Nor should teachers have students use computers and other tools of technology only to add special effects; such "bells and whistles" are not likely to offer educational advantages.

Selecting Software

Although there is a great variety of software available, educators have limited time and energy to evaluate and select programs. It is important to remember that software is not the curriculum, but rather is a tool to support learning. Computers or software cannot and should

not replace skilled and caring teachers. Research on learning and the human brain highlight the importance of children having caring interactions with responsive adults. But as a tool to help children learn, create, understand, explore, and present, software can be a powerful and effective aid.

As a first step, consider the intended purpose of the software. When educators search for new books to use in the classroom, they have in mind a mental list of the criteria they consider essential. Similarly, knowing what the software is intended to support will help to narrow the field dramatically. For young children especially, it is also important that the software be developmentally appropriate—that is, consistent with the way children learn and develop—and is used appropriately in the context of the curriculum (NAEYC, 1996).

Young learners benefit from software that:

- Allows for active learning with students making decisions
- Is multisensory and multidimensional
- Has age-appropriate expectations
- Is flexible, easy to use, and open-ended
- Allows children to explore without fear of making mistakes, and responds to their exploration in ways that encourage further investigation
- Encourages language by eliciting excitement

(Davidson & Wright, 1994; Davis & Shade, 1994; Murphy & Thuente, 1995; NAEYC, 1996)

As the earlier section on play discusses, young children learn through exploration and play, through open-ended activities. This is true with software and technology as well as with blocks and dress-up clothes. Software that is open-ended allows children to explore and discover. Open-

PHOTO BY MOUNT BURNS

ended software is more likely to support active learning as children make real choices and then find out the effect of their decisions. For instance, this type of software may ask children to decide what to create in a picture, how to end a story, or in what direction to take an inquiry. Drawing programs, word-processing programs, and music-making programs are examples of software that may have these characteristics, allowing children to create pictures, writing, and music that reflect a variety of abilities and interests.

Software with appealing graphics and bouncy animation that asks students to fill in the blanks with words is still drill and practice, albeit in a more attractive package. A more open-ended opportunity might ask students to select or create a picture, then write a complete sentence or story about it.

Open-ended software encourages wondering and hypothesizing, problem solving, collaboration, motivation, and a more positive attitude toward learning. These are the types of active learning and intellectual involvement encouraged by the National Research Council (Bransford et al., 2000). Well-selected software gives children opportunities to explore and create, limited only by their imaginations.

> Young children learn through exploration and play, through open-ended activities. This is true with software and technology as well as with blocks and dress-up clothes.

Tools and Applications

One of the benefits of incorporating technology into the early elementary classroom is that it allows students to combine words, pictures, and sounds in engaging, multisensory ways. However, teachers may find it helpful to consider how technology supports specific activities, such as using word-processing software for writing. In the following pages, we will explore how tools and applications of technology can be used to support specific learning goals, including:

- Working With Words
- Student Publishing
- Working With Images
- Using Audio/Visual Recorders
- Making Connections

Working With Words

Many types of software programs can provide children with scaffolding as they develop literacy skills, support that enables them to perform more advanced tasks than they could do otherwise. Bransford and colleagues (2000) compare technology to training wheels—which allow young bike riders to practice cycling, when they would otherwise fall without the support.

Bell and Beard (2000) suggest using software that supports young writers at various stages, matching the software with the stage of writing. During the scribbling stage simple drawing programs can be available in the classroom, along with blank paper and writing tools. As children begin to use real letters, they may find it helpful to use programs with picture components, such as KidPix and KidDesk. When children cluster letters together into words with phonetic spelling, text-to-speech capability or "talking word processors" such as ClarisWorks for Kids allow children to hear the words they have written.

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Talking word processors: Playing with words is an important aspect of experimenting with and thereby coming to understand language. Talking word processors allow experimental writing as young children play with rhyming words and put together groups of letters. The text-to-speech capability also supports early writers as they try to get the ideas in their heads onto paper. A child can click on a word to hear it pronounced—in effect checking to see if it is the intended word—or can hear an entire sentence or story read aloud.

Talking word processors allow children learning to read and write to experiment with letters and words and hear the results of their play. This type of software can adapt to the changing needs of the user. As reading skills increase and the child becomes more independent, he or she can select the level of support needed, highlighting a word or phrase to be spoken aloud.

As children develop writing skills, the talking word processor provides another kind of support. Talking word processors provide children with independent learning experiences as they listen to a voice reading their stories to them. Because the digital voice reads exactly what is entered on the screen, and not what the writer meant to say, it can provide the immediate, focused feedback helpful for learning. For example, a series of words without capitals or ending punctuation that is read aloud does not stop at the end of the idea. The importance of punctuation and capitals soon becomes clear. While the word processor is no substitute for a teacher, it is an effective teaching tool to support children.

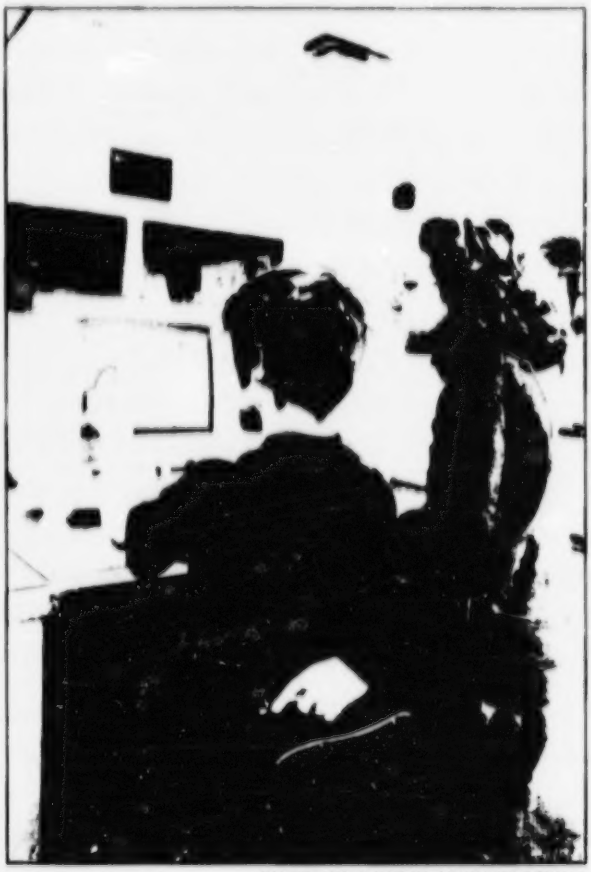
Talking books are another example of computer-synthesized speech supporting literacy development. Research indicates that the addition of speech to text may be a promising use of technology (National Reading Panel, 2000a), and allows children experience with both oral and written language. These tools also allow children learning English as their second language to hear the spoken sounds of the language while they follow along on the screen as the words are highlighted and read aloud.

Talking books commonly feature appealing graphics and animation along with the read-aloud speech. These programs can be motivating and entertaining to pre-readers and beginning readers. The teacher plays an important role as the mediator of this experience, helping children to focus on the story and engage with the ideas. Graphics and animations can be a powerful draw for children's attention, and have the potential to distract from the reading itself (Healy, 1998; Snow et al., 1998). (See also "Talking Books and Stories Told by Elders," Page 45, for a school project in which students created their own talking book about native culture.)

Hypertext: A powerful feature of multimedia and many other programs helps children make flexible connections between electronically linked resources. Hypertext—highlighted text that links to support materials, almost like an electronic footnote—shows promise for helping readers (Hasselbring & Williams Glaser, 2000; National Reading Panel 2000a). For instance, a young reader having difficulty with a passage might click on the word "rhinoceros" for a definition, to hear it pronounced, or to see a picture of the animal. Hypertext is increasingly common in software for younger children and allows them to learn through avenues in addition to the printed text. Learning environments that incorporate images and sound are especially helpful for students with limited background knowledge in a subject.

Both talking word processors and hypertext features provide extra support for students not yet fluent readers or writers of English.

Word processing: Word-processing software allows children to experiment with letters and words. Using these tools, they can focus on the meaning of the words rather than on the letter formation and fine-motor skills of handwriting. Computers and writing programs can be successfully integrated into process-oriented writing programs as early as first grade or kindergarten, and can be used by even younger students to explore written language (Clements & Nastasi, 1993). Simple uses such as creating captions for pictures of classroom activities serve a real purpose, by providing information about school activities to families. Such activities also create spoken and written language opportunities for students, both at school and at home. This is of value for all children, and especially so for English language learners and those with limited language experiences.



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Word-processing software encourages writing, and leads to increased motivation and improvement in writing skills.

Studies during the last decade repeatedly indicate that word-processing software encourages writing, and leads to increased motivation and improvement in writing skills. Such software:

- Allows children to compose longer and more complex stories and worry less about mistakes (Davis & Shade, 1994)
- Facilitates positive attitudes toward writing and word processing among children from kindergarten through primary grades (Clements & Nastasi, 1993)
- Encourages students to write more, more effectively, and with greater fluency (Apple Classrooms of Tomorrow, 1995)
- Helps children gain confidence in their writing and increases motivation to write more when using computers than with paper and pencil (Clements & Nastasi, 1993)
- Makes revising, a key practice for improving writing skills, less daunting (Wood, 2000)
- Encourages students to put more effort into the finished product because they often take the idea of being "published" seriously (Healy, 1998)

One teacher refers to the word processor as providing a screen that students can project stories on, giving them a way to express ideas for others to enjoy. Young or reluctant writers may limit

themselves to short pieces of writing or few revisions because of the effort involved to manually rewrite, reorganize, or revise toward a finished piece. Seeing the words emerge consistently formed and neat on the page can be rewarding for writers, especially those who do not find it easy to produce a neat handwritten copy or who have not always been successful.

Portable keyboards: Lightweight, inexpensive keyboards are tools that offer basic text editing features for composing, revising, and printing. These machines offer the power of word processing in a size that's easy to take almost anywhere, allowing children (or adults or older students who take children's dictation) to write, take notes, edit, and electronically store text or record impressions outside the classroom and on field trips. The text can then be sent directly to a printer, or transferred to a computer for formatting and adding graphics if desired. The adaptable tools lend themselves to new uses, and to new ways of accomplishing familiar tasks.

Portable keyboards also can extend familiar learning activities. In a common group-writing activity, each child writes a sentence and then passes the paper on to the next student. As an alternative, each child types in a portion of the story on the keyboard, then hands it on to the next child, until the story is completed. The portable keyboard adds a new dimension by permitting children to easily revise and add to the original framework of the story. They now not only have fun collaborating on a story, but they also can continue to build on the ideas and create a final story.

Presentation: Word processing programs encourage the *process* of writing by making revisions less difficult and labor intensive. As the studies show, this is a major strength. Sometimes, however, students become enamored with other less-valuable features of the programs. Teachers may need to remind students that the content of the writing is important, and that the presentation, including pictures and formatting, is to help get across the ideas and cannot substitute for the ideas. Writing and art projects may go through many drafts or revisions before they reach final form. This is another instance where writing for an audience encourages quality—when children know that a large audience will read their work, they better understand the need for revision and editing and are more willing to put in the effort.

Student Publishing

Writing has more meaning for students when they see that it has a purpose and reaches an audience. Technology makes the publishing process easier and more immediate, and can also help introduce students to the process of revision. When work is to be published to a broad audience, it is easy to make the case for revising and polishing the final product.

Class newsletters: As we know, students benefit when they write for a purpose, and class newsletters are a great way to inform families about classroom activities. Students can use any word processing software to write, design, and distribute a class newsletter. This project becomes a powerful instrument for encouraging writing, because students are writing for an audience they know. Working collaboratively, students engage in lively discussions about what topics should be included, which story comes first, and how graphics and fonts can be used to communicate their ideas. These activities give students a voice in making real decisions, and support the process of editing and revising written work.

Children may be surprised at first by the amount of time and effort needed to write a simple article, beginning from the initial idea. The satisfaction of hearing back from the readers—classmates, family members, and others in the school community—

makes it all worthwhile and is a powerful motivator. The newsletter is an instructional vehicle as well: Students receive instruction in context as the teacher and a small group work together through the stages of writing and editing an article.

This same idea is also useful with younger writers. A second-grade teacher uses a large monitor to write a class newsletter with her students. The newsletter serves both as a shared writing activity and as a way of informing parents about classroom activities. As children dictate their ideas she enters the text into the computer, then they work together to revise the writing. All the writing and revising is visible to students and provides a guided practice in how to revise and improve writing.

Little books: Technology currently available in many schools allows authors of all ages to "publish" books right in their own classrooms. Given the desire for reading matter at the children's own level, and the knowledge that young authors benefit from writing for a real audience, student publishing may accomplish multiple instructional goals. Several studies have found that children comprehend and make inferences better when reading child-authored texts than when reading other texts (Sampson, 1997). As an added benefit, using students' work to publish multiple copies of these "little books" can be a natural means of adding to the classroom stock of reading materials.

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Encourage children to create their own art to illustrate their work, whether hand-drawn or computer-generated, rather than downloading clip art or ready-made graphics. The final product will be more personal, and better appreciated by the audience. If a color printer is not available, children can hand-color a black and white copy with crayons, markers, or water colors. Hand-drawn or computer-created art can grace the cover; photographs are easy to include along with the text; and interest is certain to be high as children read about topics they care about, written by authors they know. Photocopier machines and standard printers allow for easy printing of individual copies and group sets.

PHOTO BY DENISE JARRETT-WEEKS

Web sites: Many teachers publish student writing and accompanying artwork to the Web. Posting work to the Web and creating projects especially for this medium are rewarding experiences that bring motivation and encourage interaction. A class Web page can motivate young writers by letting them know that their work will have an audience, and a large one at that. Some teachers become more deeply involved in this area and add additional features to their Web sites. Others opt to focus on the written word and artwork, and avoid the technical aspects of these additional features. If you are interested in publishing to the Web, be certain to check with your school or district about guidelines, Acceptable Use Policies, and permission forms that may be required before posting student work, information, or photographs.

Reading instructional software: The issue of whether to use software specifically designed and marketed as useful for early literacy instruction is one many teachers face. Some schools choose to use large-scale programs as part of their literacy instruction. According to the authors of *Preventing Reading Difficulties* (Snow et al., 1998), preliminary evaluations indicate that well-designed software programs can produce gains in student performance. The study recommends addressing whether the programs are:

- Consistent with best practices in literacy instruction
- Consistent with classroom curricular goals, as well as the specific needs of individual children
- Used as a complement to—not a substitute for—effective teaching or a good curriculum

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The role of the teacher is essential for effective teaching, as is the selection of software to be used. As with the software choices for kids, the design of software for instruction, its goals, and its appropriateness for the needs of the students are critical in the selection of the software. Wood (2000) advises that much of the currently available software is not pedagogically sound, and cites software that supposedly teaches vocabulary by having students match definitions to words. Unless words are presented in multiple contexts, students' understanding will be limited to a narrow portion of the word's multiple meanings, and they will not really feel comfortable with new words. The National Reading Panel (2000a) reinforces this idea: "Repetition and multiple exposures to vocabulary items are important. Learning in rich contexts, incidental learning, and use of computer technology all enhance the acquisition of vocabulary . . . dependence on a single vocabulary instruction method will not result in optimal learning" (p. 14). Including computer software that provides rich experiences with words as part of a complete vocabulary program can be part of a strategy to improve instruction; relying on the software to provide the instruction is not sound pedagogy.

PHOTO BY JEFF JONES

Perhaps most important to keep in mind is that "the potential educational value depends on the quality of the software itself. Software can promote learning only to the extent that it engages students' attention—yet software that engages students' attention may or may not promote learning" (Snow et al., 1998, p. 265). The characteristics that attract students and are marketed successfully may not include the subtle features and dynamics needed to be effective educationally.

As we devise strategies to use these new tools in productive ways, we should lean on what has been learned through decades of research on learning and literacy instruction.

Working With Images

While the focus is usually on computers in discussions of educational technology, several useful tools are available that allow students to record and manipulate visual images. Whether the format involves snapshots, video footage, or digital

images, photography records students' activities while they are at work, as well as recording performances and special events. Other tools allow students to create and manipulate their own artwork, which they can use to express themselves before writing, or in combination with writing. Teachers are finding creative ways to use these visual images to promote conversations and storytelling, activities that build students' literacy skills.

Photos: Children love pictures, and digital cameras offer immediate results. During activities of the day, the teacher or students can take photos. Because the images can be viewed on the camera, there is no question whether the picture turned out. Children can add their own captions—dictated to an adult or to an older child—to tell a story in pictures and words. This is a great buddy activity for those not yet writing. Many teachers use photos as motivators, providing quick feedback to students. Photos in the hallway or classroom celebrate successes and remind students of activities and learning from the larger community. Some teachers have begun posting pictures on school Web sites. Photos share the learning with other students, parents, and community members. Photos can also introduce teachers and staff members to new students and families during home visits.

Kindergarten and early childhood teachers face a unique challenge as they try to integrate computers and technology into the curriculum in meaningful ways with students who are pre-readers and pre-writers. Pastor and Kerns (1997) designed an "experiment." Their challenge was to facilitate reading and writing literacy through computer technology without inhibiting children's creativity. To do this they focused on digital photography to document activities rather than on educational software. Because so many kindergarten activities do not use paper and pencils, digital photos were an easy and effective way to document experiences and save the moment. Children used the camera, downloaded photos, and cropped and altered the photos. At first teachers began creating a slide show of the year's activities, then children took over the job.

The rewards of the project were that all the children were involved, including many previously intimidated by computers. Children could highlight their interests, strengths, and talents, and the immediate documentation of experiences—the photos—stimulated dialogue among the children. The photos were also a great stimulus to writing as they captured reality while it was still fresh. The children were able to express their artistic sensibilities by manipulating photos, using the computer as a tool to do this. The entire process stimulated problem-solving strategies and resulted in satisfaction and enthusiasm.

Clearly, the digital camera plays an important role in early childhood classrooms. It offers children a way to preserve and reproduce special moments for reflection, and is a potential stimulus for writing. Teachers can use these preserved moments for further discussion, for use in the curriculum, and to share with parents.

Visual aids: Public speaking can be less threatening and more effective when the speaker provides a visual element for the audience to focus on. Pictures, graphs and charts, or slide shows can show information that the student wants to convey in a visual form, while he or she provides information orally. This strategy is for all levels. Young children can create a story with pictures and record themselves telling the story aloud. Teachers find visual presentations helpful; photos of classroom activities allow parents to "see" how the teacher teaches, as well as hear about it. Many programs allow children to create electronic slide shows. Programs such as KidPix software are widely used with pre-writers, as well as with older students. These programs allow children to

PHOTO BY JEFF JONES

draw their own pictures using a variety of easy-to-learn tools. Pre-readers use icons to guide them as they create pictures, sequence them into a slide show, and present the finished project. The technology allows children to return to the project to revise and add to their work, encouraging understanding and improvement. The slides can also contain words in either written or recorded form.

Microscopes: Handheld microscopes that display high-quality magnified images on the computer screen are finding great use in classrooms. In addition to supporting curiosity and scientific investigation with students of all ages, they offer younger students a stimulant for language, opportunities for discussion, and an environment for introduction and use of academic and content-area language. Learning vocabulary in this manner allows children from all backgrounds to learn and use words in context, cementing their understanding of the terms. For children with limited English proficiency, the use of such tools provides a shared background of experience and language with classmates.

Using Audio/Video Recorders

Storytelling, role-playing, and dramatic play offer valuable opportunities for children to develop their language skills. A variety of technologies can be used to record children's stories and capture their playful dialogues. When they listen to the tapes or watch videos of themselves later, children are captivated by their own language skills and often reflect on the activity and on their learning.

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When adults write down children's stories—whether directly from children's dictated words or transcribed from a tape recorder—children see how the spoken word can turn into the written word. These activities integrate all aspects of literacy: speaking, listening, reading, and writing. They help children develop their storytelling ability and an understanding of how sound translates to print. Children learn that:

- What they say can be written down
- What is written down can be read
- What others say can be written down
- They can read what others write down

(Novick, 1998)

> "We discovered very quickly that the opportunity for children to talk to each other online through their written text, was providing them incredible motivation."

Tape recorders support early literacy experiences. They allow children to listen to recorded stories or songs, or to follow along in a book as they hear a story being read on tape. Children can record family stories, their own made-up stories, poems, and songs, or themselves reading aloud. Hearing a recording offers children an opportunity to revise a story to add more details, a different ending, or new characters. The immediacy of digital and audio replay and playback on the computer offers students control and choice.

Tape recorders offer many other ways to support student skills. Recordings allow children who are uncomfortable in the spotlight to shine without discomfort. They also allow children with a variety of learning styles to learn, practice, and demonstrate skills.

Tape recorders—or tape recorders used together with still cameras, or camcorders that record sound as well as moving images on videotape—can be used in powerful ways as children learn about their families and communities through interviews and oral history projects. (For examples, see "Putting It All Together," starting on Page 45.)

Making Connections

Technology can promote understanding and help build communities by linking students from across the country and around the world. Many teachers are using e-mail to help students connect with electronic pen pals. This can be an exciting and motivating way to encourage writing and reading, and correspondence is typically faster than traditional postal service and so maintains the interest of the children. Teachers find that children strive to communicate clearly with their distant friends and eagerly wait for responses. By exchanging digital pictures, students come to feel as though they really know the other students.

Electronic letters provide an engaging framework for children to learn about the larger world and to connect new knowledge to their own experiences. Many teachers find that having a group of children writing to a group in the other class is more successful than pursuing exchanges with individual students; that way, no one is left out if a student moves or does not answer a letter. Some teachers use e-mail to have students exchange information about a particular topic. Classes in Alaska and Arizona, for example, might use e-mail to compare rainfall patterns or learn about the people indigenous to each region.

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Tammy Halfacre teaches kindergarten in Hoonah, Alaska, and uses technology to connect her students with the world outside her community. She begins the year writing to pen pals in New Jersey and Texas. As she says on the school Web site, "Starting the year writing to our new Pen Pals is an exciting way to introduce writing, letters, sounds, signing their name, and patterns." The class loves getting mail, and they communicate with group letters, individual letters, and by e-mail, including exchanging digital photos with their pen pals. Later in the year she uses pen pals to teach letter writing, along with mapping skills and social studies.

Another exciting possibility is creating the online collaborative projects that bring together classes from around the country, or around the world. A teacher writes of online projects in collaboration with other primary teachers:

"We discovered very quickly that the opportunity for children to talk to each other online—and that's how they describe it—through their written text, was providing them incredible motivation to work hard on the writing skills that we were doing in the classroom. ... They had the audience, they had a purpose for writing because they knew someone was going to read their writing, and they had an expectation that they would get a response back—these are all important parts of the writing process" (Interview, 2000).

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PUTTING IT ALL TOGETHER: Examples From the Field

As teachers become familiar with the benefits and possibilities of technology for young children, they gain confidence in their own abilities to harness these new tools for innovative, integrated projects. We close with examples of projects that have the power to extend learning far beyond the classroom.

Talking Books and Stories Told by Elders

Teachers at Tulalip Elementary, in Marysville, Washington, have found that a classroom technology project can also serve to provide young children at home with unique literacy and technology experiences that help to prepare them for school.

When planning for kindergarten registration, staff members brainstormed ideas of what to include in a take-home packet for the pre-kindergartners. The typical assortment of books and magnetic letters came to mind first. But excitement grew when fourth/fifth-grade teacher David Cort suggested putting together a "talking book" of a traditional Tulalip story on CD-ROM. Because the Tulalip Tribes have given each family in the tribe a computer, the CD-ROM would be a resource that could be used by all families.

Supported by the school district and the Tulalip Tribes, school and tribal teachers have been collaborating to infuse more Tulalip language and culture into the curriculum. Some of the non-Native teachers have been taking lessons in Lushootseed—a native language that originated on the east side of Puget Sound—and teaching it to their students. Until recently, this language was spoken by only a handful of elders. In addition, Cort's reading curriculum includes reading and retelling traditional Tulalip stories.

Accordingly, in a project that links technology with literacy, Cort's students are designing the talking book. To do so, they are learning to use Web page design tools. The student drawings of the main characters of the story are artistic in their own right. They were modeled after the traditional Tulalip way of drawing or carving, which was very simple and realistic compared with the more stylized art commonly associated with Northwest Native art. The students' enthusiasm is apparent as they show visitors the witty animation and sounds they have created for the book's illustrations—a baby frog catching a buzzing fly, a group of ants marching across the screen, a spider spinning a web around the baby frog.

The talking book tells the story "Owl and Frog," a traditional story told by Martha Lamont, a Tulalip, and recorded by Thom Hess in 1964. It was transcribed by Vi Hilbert and translated into English by David Cort. The story describes how the owl and frog came to be the animals they are. It uses Lushootseed story features such as repetition and circular figures, sentences that repeat the same idea. These story features not only lend beauty to the tale, but also help listeners attend to the patterns and remember the story better, according to Cort.

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The story is told in both English and Lushootseed, with the two languages displayed side-by-side on the computer screen. Each phrase is spoken aloud when a user clicks on it with the computer mouse, and one can hear certain words pronounced again by clicking on them. Students provided the expressive voices for the English version, and Lamont's recording is the voice of the Lushootseed version. There is also an option to hear the Lushootseed version uninterrupted. Featuring a picture of Lamont, this option exudes the feeling of hearing a story told by a grandmother.

Thus, this project integrates literacy, technology, art, and culture into a meaningful activity that benefits Cort's students, pre-kindergartners, and their parents and family members.

Many of the elements of this project can be seen on the school's Web site: www.msvl.wednet.edu/elementary/tulalip_site/index.htm

This project integrates literacy, technology, art, and culture into a meaningful activity that benefits Cort's students, pre-kindergartners, and their parents and family members.

Connecting With Families and Communities: Enhancing Family Literacy

To help families increase computer literacy while engaging in enjoyable family literacy activities, staff at Richmond Elementary in Salem, Oregon, received grant funds to purchase computers and digital cameras to offer night classes to all families. During structured classes open to four families over a six-week period, parents and children together learn to use the Internet and digital cameras, and how to edit their photographs on the computer. After discussing their family background with extended family members and researching their family history on the Internet, children and parents decide what pictures and stories to include in their jointly created memory books. Recently, their stories and pictures were displayed at an open house at school and at the Marion County Fair.

Bilingual assistant Irene Valdivia says, "This is hands-on learning, and they pick it up quickly. And the money that comes into the school goes out into the community. Families take their new skills and help other families. It's their way of giving back."

Continued access to the computers and cameras after school enables families to continue the project after the classes end. One family comes in almost daily to do homework together. "It's impressive," fourth-grade teacher Rawlins says, "to see the entire family—Mom, Dad, and all their children—making homework a family activity."

This project illustrates the benefits of integrating technology instruction into broader literacy goals. Rather than teaching computer skills or literacy skills in isolation, this innovative project teaches families to use technology as the tool for creating an heirloom that is rich in meaning for parents and children alike. Children's language skills grow as they engage in the activities of talking, listening, reading, and writing in the company of their own extended family members. The decisionmaking that goes into creating the memory books (for example, making choices about which photographs to include, and which stories to tell) offers

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children more opportunities to use their language skills in meaningful ways. Making use of the Internet for research connects children with the larger world and opens new doors for using their language skills.

Monsters, Mondrian, and Me

Fourth-grade teacher Lucinda Surber in Palo Alto, California, used monsters as an engaging beginning to an extended collaborative project between classrooms at two elementary schools.

Students at each site worked in pairs to create portraits of monsters, and then composed detailed descriptions of their creations. The students in the partner class attempted to re-create the drawings by following the written descriptions, which were sent to them through e-mail. Then, using computers to scan and exchange images, students compared their original portraits with the re-creations.

Students at each site reflected on their descriptive writing skills by looking to see how closely the reproduction matched the original composition. Students wrote an analysis of why the re-creation succeeded or failed to match the original, and how their partners were helped or hindered by the written description. A class Web page showcases the colorful pairs of monster drawings along with the descriptive and analytical text.

In the Mondrian phase of the project students used the same process of writing, exchanging descriptions, drawing, and reflection, this time starting with a work of modern abstract expressionism. Receiving students attempted to duplicate the art works from the descriptions. The second-generation paintings were compared to the original works for detail and accuracy.

In the Me stage, students studied self-portraits of famous artists and then created their own self-portraits in the style of either Georges Rouault or Vincent van Gogh. During this phase they worked individually to write detailed descriptions of their faces, and then to reflect on the second-generation portraits.

The project uses art and telecommunication to illustrate the need for clear and precise language, and engages students' language skills in many ways. Working in pairs to create the original artwork brings about lively conversations. Student pairs must ask and answer a wide range of questions while imagining and drawing their monsters. Conversations continue as students shift from talking about art to making art to writing about their artwork in a way that describes every detail. Because students know the purpose of their words and that they will be read by an audience, the work and the language take on added significance. On the receiving end, students also work in pairs to make sense of the descriptive writing and turn it into a drawing of their own. Again, students must ask and answer a number of questions about the process in order to create a drawing.

Technology is woven throughout this project. Students use word processing software for writing, e-mail to exchange information, and scanners to turn their drawings into digital images. The project can be viewed online at www.pausd.palo-alto.ca.us/barron/mmm/mmm.html

Celebrating Families

At Cherry Valley Elementary School in Polson, Montana, celebrating the lives of family and community members takes many forms, and often integrates many aspects of literacy—oral, written, and the visual arts. Each year, at a Family Heritage Museum in the school cafeteria, children display the results of their research on their own

family tree. Interviews with parents and grandparents yield rich stories, which the children write and accompany with photographs and illustrations. Recently, the use of technology—including computers for word processing and publishing, tape recorders, and digital cameras—has added to the excitement of this popular project.

For several years, both in multiage groups and with their classrooms, children have been visiting a local nursing home and establishing relationships with one or more residents. Children then interview the residents, who frequently tell stories about their lives. The use of tape recorders helps students tell the stories, using the words of the residents. In addition, older students take notes. They then write the stories, share them with the residents who make suggested changes and edits, publish the stories, and take them back to the nursing home, where they read to the elderly residents. The project has been met with enthusiasm from the staff at the nursing facility and the residents themselves. A social worker at the facility writes:

PHOTO BY DENISE JARRETT-WEEKS

I have witnessed contacts between young and old, which can only be described as "touching." Residents are able to hold a child's hand or see a bright young smile. They look forward to these visits and are delighted by the children's eagerness to please and entertain. These intergenerational exchanges are a benefit for both age groups. They nurture an understanding and acceptance of age difference.

From a literacy standpoint, the project is well-designed on many levels. Students know that they will share their products with residents of the nursing home. This makes the project more meaningful—they know their work will have an audience. The project is designed to spark conversations between generations—dialogues certain to

expand students' vocabularies and to inform students about their community's history. As students revise and edit their work, they gain proficiency in their skills as writers.

Technology provides the students with tools for recording oral histories, taking photographs, and publishing the results of their research.

Where To Begin?

After hearing these inspiring examples from other classrooms, many teachers may now be wondering, Where do I start? How do I begin to use technology with my students? What do I need to have, and to know?

First, take a deep breath. And relax! You already possess the most important qualities for adding technology to existing classroom resources: You are vitally interested in the learning and well-being of your students, and you have the knowledge and skills for knowing how to meet their learning needs and support their growth. These final pointers offer some basic information that may help you on your journey.

How should I begin?

Start small. Try one new strategy or one new tool. Work with that until you and the students feel comfortable using it, and have found ways that it enhances the lessons. You may wish to start using a camera in new ways to document learning, perhaps having the children take picture of completed tangrams or of a partner's project. Or you may introduce students to using the word processor to draft a story. Later, they can revise the draft and add pictures. If you have a scanner, you can scan student pictures into their stories.

What do I need?

Don't be concerned about needing all sorts of new and expensive equipment. Use whatever you have available, including the more "mature" computers still found in many schools. If the machine is older than your students, so what? The most common use of computers is still for word processing, and even computers that are many years old continue to be powerful tools. Many teachers use a variety of machines of different ages and varieties. If software is available for your computer, you've got a great resource. (Did you know that Sony PlayStations, MacIntosh Classics, and 386 computers each have more computing power than those specially designed to travel to the moon aboard the Apollo spacecraft?)

What kind of word processor do I need?

Any word-processing program can be used with children. If you already have, or can buy, software that is designed especially for children, that's great. But the differences (between software for children and all-purpose software) are less important than how the program is used. Children's software typically includes color, child-friendly graphics, sound, and perhaps larger-size type. Most adult software includes the same features, except for children's graphics. And as noted earlier, children benefit more from creating their own graphics than from importing canned clip art. The text-to-speech capability can be very useful for students, but it is also available either as part of the operating system or as an inexpensive software add-on.

What do I do if I have very little software (and can't afford more)?

Another common concern is that a class needs to have a lot of software available for students. This is certainly true with library books, and having a variety of resources can be useful. But if the software is mainly used for productivity—writing, creating, drawing, and so forth—then a wide variety of programs is not necessary. The aim is to have available the tools needed to accomplish the task.

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Too many choices can actually be a drawback if they distract from the purpose, which is to be creative and to express oneself.

I have very little experience with technology. How do I teach my students?

Of course, most of us would like to know more about computers, software, and the other new technologies. But our students have grown up with them—today's children are younger than the tools! Kids take technology in all its forms for granted. They are not intimidated and, most important, allow themselves time to explore and play with it. For all these reasons, teachers would be hard-pressed to stay ahead of all students all the time with all technology. Instead, why not celebrate students' knowledge? Let them lead the way with the "how-to's" while the teacher leads in providing the "whys." Working together, students and teachers will find new opportunities to be excited about learning and successful in the important realms of literacy, science, math, and the many other areas that contribute to understanding our world.

You can go as far as you care to on this journey, or let your students carry you along with the tide. Above all, have fun. Remember that positive experiences with literacy have a big impact on children. Don't overlook the power of example—let kids see adults try new things and learn new skills. Laugh at the problems and celebrate the successes. Your students will be richer for your efforts in this new direction. Bon voyage!

CONCLUSION

PHOTO BY MOUNT BURNS

At the beginning of the 21st century educators have a difficult challenge to meet: providing children with a solid foundation of literacy to prepare them for adulthood and today's world. We have an increasing body of knowledge on how children develop literacy skills, along with a rich literature of effective practices to nurture and increase student involvement and learning. We recognize the importance of relating education to students' experiences, and of enhancing communication and collaboration both among students and between school and community.

Teachers are creative in their use of strategies and materials to reach students. As they are demonstrating daily in their classrooms, integrating technology into learning can offer real benefits to students. These benefits include opportunities to explore in ways not otherwise possible, to connect students with people outside the classroom, to reach a wide audience through publishing in print and on the Internet, and to link learners with others, enriching the connection to the community and the larger world. As suggested by the National Research Council, these new tools can:

- Provide scaffolding and tools to enhance learning and help children solve problems
- Provide more opportunities for feedback, reflection, and revision
- Build global and local communities

Taken together, the tools of technology offer flexibility and individualization to help reach an increasingly diverse student population, provide experiences that engage their interest, and respond to a range of needs. To be successful, use of these new tools must take into account children's need to be active and involved, learning with both their bodies and minds. When it is used appropriately, with thoughtful planning and clear goals in mind, technology can be a powerful tool to motivate and stimulate creativity and learning, and foster connections with families, the community, and the broader world.

Appendix A

Professional Development Teams To Enhance Learning and Teaching

> Teachers learn best by studying, doing and reflecting; by collaborating with other teachers; by looking closely at students' and their work; and by sharing what they see (Darling-Hammond & McLaughlin, 1995)

The need to integrate technology into a classroom might easily be seen as "just one more thing" to do for already overburdened teachers and administrators. Multiple innovations may pile up against each other, leaving little time for teachers to reflect on what's working and what's not and how to make effective change.

According to Michael Fullan, Dean of Education at the University of Toronto:

> With change forces abounding, it is easy to experience overload, fragmentation, and incoherence. In fact, in education, this is the more typical state. Policies get passed independent of each other, innovations are introduced before previous ones are adequately implemented, the sheer presence of problems and multiple unconnected solutions are overwhelming. Many schools and school systems make matters worse by indiscriminately taking on every innovation that comes along—what Byrk et al. called "Christmas tree schools"—so many innovations as decorations, superficially adorned (1999, p. 27).

The last few years, however, have brought increasing recognition that teachers and teachers' knowledge gained from and embedded in their everyday work with children should be at the center of reform efforts and professional development activities (Darling-Hammond, 1994; Lieberman, 1995). The increased appreciation for practical knowledge enriched by critical reflection has produced a rich body of literature that supports teachers' need to become actively involved in their own learning process. Little (1997) suggests that the "test of effective professional development is whether teachers and other educators come to know more about their subjects, their students, and their practice, and to make informed use of what they know."

In schools designed as learning communities, all members work collaboratively to improve the learning process for both students and adults. The learning environment supports shared responsibility and leadership, risk taking, collaboration, asking and answering questions related to educational practices, and self-awareness.

Newmann and Wehlage (1995) describe three general features of a professional community:

- Teachers pursue a clear shared purpose for all students' learning
- Teachers engage in collaborative activity to achieve the purpose
- Teachers take collective responsibility for student learning

Collaborative inquiry can only thrive in a climate of mutual respect and interdependence. Key to the establishment of a community of learners is a principal who encourages teachers to examine teaching and learning, and implement ideas and programs that result from reflective practice (Reitzug & Burrello, 1995). Sagmiller explains:

> Traditionally, principals have been thought of as managers; they have been trained to think in terms of "time to be allocated," and classrooms to be designed. In this role, they often have thought of teachers and children as "things to manage," rather than as rich sources of knowledge and expertise. In a community of learners, what counts are relationships, dialogue, facilitating joint inquiry, and building a climate of trust (1998, p. 132).

In such a climate, teachers are viewed and view themselves as professionals, who are able and expected to articulate their own beliefs about teaching and learning, as well as understand the latest theory, research, and current thinking in education. In addition, teachers engage in their own research (often in concert with students and families), creating new knowledge to inform instructional practices, and design authentic learning situations (Carr & Braunger, 1998).

Professional Development Teams

Organizational structures that reduce isolation are critical to creating an environment that fosters collaborative inquiry and collective responsibility for students (Lieberman, 1995; Meier, 1995; Reitzug & Burrello, 1995). Structures such as study teams increase opportunities for teachers to share ideas, strategies, concerns, and students. Teaming leads to a sense of collective responsibility for one another and for students and provides an emotional and instructional support network, key characteristics of a learning community (Reitzug & Burrello, 1995).

Teams can take many forms, and include many activities, including examining student work, collaborative planning, sharing expertise and practices through demonstration, and visiting each others' classrooms. Pasco, Washington's, District bilingual specialist Liz Flynn notes:

> Teachers are often not given the chance to stop, to sit down with what they've learned and integrate it into their own knowledge base and apply it in a systematic manner. They need to have time to sit down with their colleagues and say, "I have a child who just isn't learning as much as I know she can. Can you give me some ideas to help motivate her?" Sharing strategies with colleagues usually works better than someone coming in and saying, "You should be doing these things."

In addition to sharing expertise with each other, book groups provide opportunities for teachers to explore children's and professional literature, "contributing to the rich, literate environment of classrooms" (National Council of Teachers of English, 1997). When professional development teams tie what is learned from book study to classroom practice and examining student work, teaching and learning is enhanced.

Schoenbach, Greenleaf, Cziko, and Hurwitz (1999) suggest that the process for enhancing professional conversations should include:

- Routines for reflection and exchange of ideas, resources, and problem solving
- Inquiry processes for exploring classroom issues and data
- A clear set of agreed-upon ground rules for the discussion and individuals prepared to facilitate conversation with these ground rules in mind

Making time. Of course, all these processes take time. The National Staff Development Council recommends that educators spend 20 percent of their work week engaged in learning and collaborative efforts—the equivalent of one day out of every week (Hirsch, 1997). "Reform efforts that rely on teachers donating additional time from their personal lives risk increasing teacher burnout, trading one resource for another," Dzubay (2001) points out. Fortunately, a number of options exist to provide time for teachers to be actively engaged in their own learning process. Of course, to implement these options, support for professional development embedded in the everyday life of the school must be supported at the district and state level. Options include:

- Cluster specialized classes—art, music, physical education, and library—on the same day of the week, creating a "resource day" and freeing teachers for development activities
- Lengthen the school day on four days and have a shorter school day on the fifth
- Use regular faculty meetings for planning and growth, rather than informational or administrative purposes
- Schedule common planning periods for colleagues in study groups or other collaborative partnerships

The Curriculum Inquiry Cycle

A commitment for continuous improvement means that it is second nature for teachers to continually assess what they are doing, why they are doing it, and how they can more effectively help children learn. The Curriculum Inquiry Cycle, developed at NWREL, is a process that supports teachers as inquirers into what they do and how they might do it better. According to authors Maureen Carr and Jane Braunger (1998), "Curriculum inquiry involves teachers in determining the critical experiences necessary to engage students in meeting challenging standards" (p. 8). The recursive process involves examining current practice, making decisions, creating optimal learning environments, and researching classrooms. Carr and Braunger explain:

> Through the curriculum inquiry cycle teachers can look deeply into their ideas about knowledge, the roles that students and teachers play in the development of knowledge, and the relationship between their conceptions of learning and teaching and the kind of learning that occurs in classrooms (p. 7).

The ongoing cycle of curriculum renewal is based on the premise that professional development should help teachers get in touch with their implicit theories or beliefs about teaching and learning to form coherent, rational theories based on evidence. A major goal of this NWREL process is to assist teachers and schools to create self-sustaining processes for improving curriculum and instruction. It is prompted by key questions central to teaching and learning:

- **Examining Current Practice**

  What does my teaching look like?
  Why do I work this way?

  What does this tell me about how I think about curriculum?

  Is my current practice making a difference in student learning?

- **Setting Priorities**

  Are my practices consistent with what is known about how people learn? Are content and performance standards reflected in my teaching practice? Am I aware of alternative models of teaching to meet the needs of diverse learners?

- **Creating an Optimal Learning Environment**

  What are the dynamics of an optimal learning environment for all children?

  What learning experiences are essential?
  What assessments are appropriate?

- **Expanding Teacher Knowledge Through Classroom Research**

  What dilemmas, questions, or concerns about teaching and learning do I want to explore? How can I collaborate more with colleagues and community members? How will I share my research?

Some suggested questions to spur reflection on the role of technology in supporting early literacy include:

- How do I define technology?
- How do I use technology in my own life?
- How can we use technology to enhance student learning? Separate areas of focus might include: oral language, vocabulary, concept knowledge, and writing.
- How can technology be used to connect with families and the larger community?

When teachers reflect on their beliefs and practices, and generate and seek answers to their own questions, everyone in the learning community is both teacher and learner. Authors Carr and Braunger conclude:

> Teachers actively involved in collaborative research open the doors of inquiry to their students. They model the importance of asking questions, looking beneath the surface of ideas to develop deeper understandings and the need to discuss and share what they learn. Students who operate in an atmosphere of reflective inquiry learn that knowledge changes as it is revisited and new meanings arise for learners as they review and research classroom questions with their teachers and peers (1998).

Appendix B

Annotated Bibliography of Print Publications

American Association for the Advancement of Science. (1999). *Dialogue on early childhood science, mathematics and technology education*. Washington D.C.: Author.

This collection of 11 papers was commissioned for the Forum on Early Childhood Science, Mathematics and Technology Education. The papers represent the latest thinking in these areas and range from early childhood learning and concept development, to first experiences in math, science, and technology, to an examination of professional development models for high-quality programs. Taken as a whole, they provide early childhood educators with sound information and insights into how pre-kindergarten children learn.

Bransford, J.D., Brown, A.L., Cocking, R.R., Donovan, S.M., & Pellegrino, J.W. (2000). *How people learn: Brain, mind, experience, and school* (Rev. ed.). Washington, DC: National Academy Press.

A project of the National Research Council, this book brings together a wealth of information from several fields including cognitive psychology, social psychology, anthropology, and neuroscience, to provide a clearer understanding of the new science of learning. This expanded edition includes information relating the research findings of the original study to teaching and learning, and how to apply the principles in practice.

Costantino, M., St. Charles, J., Tepper, S., & Baird, E. (1999). *Reading and second language learners: Research report*. Olympia, WA: Evergreen State College, Evergreen Center for Education Improvement.

This document provides a synthesis of the research on teaching and learning to read in English among second language learners. The report is a useful resource for educators and policy makers, and details strategies found to be effective and classroom practice that encourages success for ELL students.

Educational Leadership, 58(3).

The November 2000 issue of this journal is subtitled "The Science of Learning." Articles by experts from science and education provide a good overview of current information in this field, look at the implications for education, and suggest ways to use the knowledge in curriculum and classroom practice.

Gordon, D.T. (Ed.). (2000) *The digital classroom: How technology is changing the way we teach and learn*. Cambridge, MA.

This collection of articles from the Harvard Education Letter paints a picture of real people and programs dealing with new technologies and the changes they bring about. It features examples of innovation and, from a variety of perspectives, looks at the best uses and difficult issues of educational technology.

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McNally, L., & Etchison, C. (2000–2001). Strategies of successful technology integrators. *Learning & Leading with Technology, 28*(2, 3, & 4).

Three consecutive issues of the International Society for Technology in Education's journal (October 2000, November 2000, and December/January 2000/2001) feature a three-part article on strategies for successful technology integration. Part 1 looks at using technology to streamline management tasks for both teachers and students; Part 2 looks at using software in the curriculum; and Part 3 considers online collaboration, scaffolding learning by using templates, and electronic portfolios.

Nelson, O.G., & Linek, W.M. (Eds.). (1997). *Practical classroom applications of language experience: Looking back, looking forward.* Needham Heights, MA: Allyn & Bacon.

A very readable set of articles by researchers and practitioners provides perspectives and personal stories of using the language experience approach in a variety of settings. Included are chapters specifically addressing beginning reading, beginning writing, and supporting the literacy development of second language learners with technology.

Papert, S. (1993). *The children's machine: Rethinking school in the age of the computer.* New York, NY: Basic Books.

Papert worked with Jean Piaget for five years, co-founded the Artificial Intelligence Laboratory at MIT, and was an early proponent of using computers with children as tools for learning and to enhance creativity. This book will lead you to reconsider the relationship between children and computers as he offers a vision of technology's potential for learning.

Snow, C.E., Burns, M.S., & Griffin, P. (Eds.). (1998). *Preventing reading difficulties in young children.* Washington, DC: National Academy Press.

This comprehensive book from the National Research Council addresses the complex set of factors that contribute to literacy development. Written by a committee with a range of backgrounds, it presents effective practices for learning to get meaning from print and offers instructional strategies and recommendations for practice with children pre-kindergarten to third grade.

Annotated Bibliography of Web Sites

AskERIC Lesson Plan Collection. Lesson plans relating to computer science from the federally-funded Educational Resources Information Center (ERIC), including a number for preschool, kindergarten, and the early grades.
http://ericir.syr.edu/cgi-bin/lessons.cgi/Computer_Science

Center for Children and Technology. Founded in 1980 to address the issue of technology and learning, CCT's work covers a broad range of activities, and investigates the roles that technology can play in improving the circumstances of teaching and learning.
http://www2.edc.org/CCT/cctweb/index.html

Children and Computer Technology. This issue of *The Future of Children* focuses on children's growing use of computer technology both in school and at home. The articles summarize the knowledge and research available on how computer use affects children's development, whether it increases or decreases disparities between rich and poor, and whether it can be used effectively to enhance learning.
http://www.futureofchildren.org/usr_doc/vol10no2.pdf

Computer-Based Study Strategies. The Center for Electronic Studying at the University of Oregon developed this set of Computer-Based Study Strategies. The strategies provide ways of accomplishing school-related tasks, and are based on research to help students become effective "studiers."
http://cbss.uoregon.edu

Computer Ergonomics for Elementary School Students. This site, designed by the Oregon Public Education Network, shows simple and affordable ways to make sure that a student's body is safe and comfortable while using a computer. Many suggestions can be modified for use in other early childhood settings.
http://www.orosha.org/cergos/index.html

Computers and Young Children. This ERIC Digest discusses questions about when children should start using computers; developmentally appropriate computer activities in preschool, kindergarten, and early primary classrooms; benefits of computer use; integration of computers into classrooms; and teacher training.
http://ericeece.org/pubs/digests/2000/haugland00.html

Connecting Technology With Brain Research. This site identifies five important brain concepts, provides questions to consider when designing a learning environment, and offers suggestions for connecting technology and brain concepts to enhance student learning. Links to other resources include additional information and project examples.
http://edservices.aea7.k12.ia.us/edtech/classroom/brain/

CyberGuides: Teacher Guides and Student Activities. These supplementary, standards-based, Web-delivered units of instruction center on core works of literature for K–12 students, and are based on California Language Arts Content Standards from SCORE (Schools of California On-line Resources for Education).
http://www.sdcoe.k12.ca.us/score/cyberguide.html

Early Childhood Technology Literacy Project. This award-winning project from Montgomery County (Maryland) Public Schools integrates technology into instruction in K–2 to increase early childhood students' skills in reading and writing. The Web site includes information and resources for parents and teachers.
http://www.mcps.k12.md.us/curriculum/littlekids/

Early Connections: Technology in Early Childhood Education. This joint project of NWREL and the Northwest Educational Technology Consortium examines how technology connects with the way young children learn. The Web site provides educators and care providers with information and online resources for the appropriate use of technology.
http://www.netc.org/earlyconnections/

Integrate, Don't Isolate!—Computers in the Early Childhood Curriculum. This ERIC Digest examines how children gain the most valuable computer skill—the ability to use computers as a natural tool for learning—only when computers are integrated into the curriculum as a vital element for instruction, and applied to real problems for a real purpose.
http://ericeece.org/pubs/digests/1994/shade94.html

The Internet and Your Family. The American Academy of Pediatrics offers practical information and guidelines on keeping your family safe on the Internet.
http://www.aap.org/family/interfamily.htm

The Learning Space. The mission of this teacher-led organization is to provide educators with opportunities and tools to develop, implement, and share effective uses of technology to improve student learning.
http://www.learningspace.org/

Media Workshop New York. Media Workshop focuses on connecting new media and technology to teaching and learning. The site provides resources including online workshops, suggested Internet Web sites for K–12 educators, and examples of student work and lesson plans integrating technology and new media.
http://www.mediaworkshop.org/index.html

Myths and Realities About Technology in K–12 Schools. This article in LNT (Leadership and New Technologies) Perspectives examines the misconceptions or myths about what is required to gain substantial educational returns and tries to answer the questions of whether and in what ways technology can improve education for large numbers of students.
http://www.edc.org/LNT/news/Issue14/feature1.htm

National Educational Technology Standards (NETS) Project. NETS for Students describes what students should know and be able to do with technology, and includes the National Educational Technology Standards and Performance Profiles for Students.
http://cnets.iste.org/

Technology and Young Children—Ages 3 Through 8.
A position statement on the topic from the National Association for the Education of Young Children, adopted 1996.
http://www.naeyc.org/resources/position_statements/pstech98.htm

Technology and Young Children. The Technology & Young Children Interest Forum of the National Association for the Education of Young Children was established to lead discussions, share research and information, and to demonstrate best practices regarding technology so it can be used to benefit children through eight years of age.
http://www.techandyoungchildren.org/index.shtml

Young Children and Technology. From the book Dialogue on Early Childhood Science, Mathematics, and Technology Education, this paper reviews the research in three broad areas: social interaction, teaching with computers, and curriculum and computers; as well as describing a new project that illustrates innovative, technology-based curriculum for early childhood education.
http://www.project2061.org/newsinfo/earlychild/experience/clements.html

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